

PROCEEDINGS OF THE UNITED STATES NATIONAL MUSEUM



SMITHSONIAN INSTITUTION
U. S. NATIONAL MUSEUM

Vol. 106

Washington: 1956

No. 3364

CHIGGERS OF THE GENUS *EUSCHÖNGASTIA* (ACARINA:
TROMBICULIDAE) IN NORTH AMERICA¹

By CHARLES E. FARRELL²

Introduction

In this paper the systematics of the genus *Euschöngastia* in North America are studied; 15 previously described species of *Euschöngastia* are redescribed; four previously described species are synonymized; nine new species of *Euschöngastia* are described (one of these having been divided into two subspecies); the morphology, geography, and ecology are considered in descriptions; a key for North American *Euschöngastia* is given; and the nomenclature of *E. oregonensis* (Ewing, 1929), *E. californica* (Ewing, 1925), and *E. setosa* (Ewing, 1937) are considered.

The author wishes especially to thank Dr. G. W. Wharton for his assistance throughout all phases of this work and Dr. H. S. Fuller for making available a manuscript copy of his paper on the Trombiculidae in the Oudemans collection that was published in

¹ This paper is based on a thesis submitted in partial fulfillment for the degree of Doctor of Philosophy, Duke University, Durham, N. C., in 1951. The investigations were supported in part by a research grant to Dr. G. W. Wharton from the Division of Research Grants and Fellowships of the National Institutes of Health, U. S. Public Health Service.

² Department of Biology, Vanderbilt University, Nashville, Tenn.

1952. To all other persons who contributed materials or information, the author is also very grateful.

Chiggers are the larvae of trombiculid mites. They are the first active developmental stage in a life history which includes seven steps—egg, deutovum, larva, nymphochrysalis, nymph, imagochrysalis, and adult. Although very small, they can be seen by the naked eye. They are important parasites of terrestrial vertebrate animals, and they are the only stage of the trombiculid life cycle which is known to be parasitic. So far as is known, the two other active stages, nymph and adult, are predacious on small arthropods and arthropod eggs. Chiggers are widely distributed throughout the world. Several species are irritating pests of man. Wherever these species occur they have been given common names by the people living there; and they are known by reputation in places beyond where they are found.

Recently there has been a great awakening of interest in the study of chiggers. During World War II, under the medical urgency to find out everything possible concerning the vector of scrub typhus in the Pacific area, intensive investigations were begun. The interest aroused in this effort, which still continues, has spread to chiggers in general and has brought about rapid development in the systematics of the group.

Few areas have been studied intensively. Experience indicates that whenever a new region is investigated new forms as well as known species will be found. From September 1947 until December 1949 small mammals were trapped in Duke Forest, Durham County, and Orange County, N. C., for the purpose of determining the chigger populations. During the same time, chiggers removed from mammals collected by the Pennsylvania Mammal Survey were sent to Duke University for identification. A number of shipments were received from Ohio. The most numerous chigger specimens and species secured were of the genus *Euschöngastia*. With these collections as a nucleus, a study of the systematics of the genus for North America was undertaken.

Review of the literature

SYSTEMATICS: There has been some confusion in the historical development of the family Trombiculidae. For many years the life histories of the mites were unknown; and, when different developmental stages were collected, they were named independently. Later, as life histories were determined, shifts of nomenclature were required by application of the law of priority.

In 1905 Berlese described *Trombicula minor*, a mite generally accepted to be a nymph with a body shaped like the figure 8. The monotypic genus *Trombicula* was erected for it in the family Trombidiidae. In 1912 Oudemans published a taxonomic summary of chiggers with descriptions and notes on all known species. He included these larvae in the genus *Microtrombidium* Haller, 1882, type species *M. purpureum* Haller, 1882, or in several genera he himself had created in 1910 and 1911. These genera also were in the Trombidiidae.

In 1916 the first successful rearing of nymphs from engorged chiggers occurred. In that year Kneissl reported rearing nymphs of the European pest chigger *Microtrombidium autumnalis* (Shaw, 1790). He observed they were shaped not like *Microtrombidium* but had the same form as *Trombicula*. He changed the name to *Trombicula autumnalis*. In 1917 Miyajima and Okumura made similar observations and changes with *Trombicula akamushi* (Brumpt, 1910). Later, other chiggers which had not been reared to nymphs were moved from *Microtrombidium* to *Trombicula* by various workers.

Ewing (1929d) established the subfamily Trombiculinae for the vertebrate-infesting chiggers, separating them from the arthropod-infesting mites of the family.

Willmann, in 1941, published the results of his examination of the type specimen of *Trombicula minor*. He determined it to be an adult female, not a nymph. However, this discovery had no effect on the classification. By this time adults of other species had been reared. These adults from cultures were congeneric with *T. minor*.

Ewing (1944a) proposed the new family Trombiculidae with two subfamilies, Trombiculinae and Hemitrombiculinae. Womersley (1944) added the subfamily Leeuwenhoekiiinae and in 1945 raised the group to full family status. Ewing (1946a) retained Leeuwenhoekiiinae as a subfamily and added the Walchiinae. Wharton (1947b) agreed with Ewing's determinations, added the subfamily Apoloniinae, and redefined the family on the basis of larval characteristics. In his new definition Wharton excluded the subfamily Hemitrombiculinae, which Ewing (1949) has said could well be made a separate family. At the same time Wharton gave a new diagnosis to the subfamilies based chiefly on the number of segments in the larval legs. With this development the classification of chiggers took on its present form at these intermediate levels. Wharton, Jenkins, et al. (1951) published a key

to the subfamilies and the genera. *Euschöngastia* is in the subfamily Trombiculinae.

The historical development of the genus *Euschöngastia* Ewing, 1938, has been confused only by differences of opinion or interpretation which have occurred during the recent growth in the systematics of chiggers. As groups of species were shifted into new genera in an effort to get more natural combinations, acarologists did not always view the problem in the same way and did not shift their nomenclature simultaneously and identically.

The oldest species included in *Euschöngastia*, as it is defined at present, is *E. trouessarti*, described by Oudemans in 1910 and placed in his new genus *Schöngastia*, type species *Thrombidium vandersandei* Oudemans, 1905. Only three species were included. Later, many species were added by several workers. Ewing (1929d) separated several species from *Schöngastia* and placed them in a new genus, *Neoschöngastia*, type species *Schöngastia americana* Hirst, 1921. *E. trouessarti* was included in the new genus in 1932.

In 1938 Ewing erected the monotypic genus *Euschöngastia* for his new species *E. americana*. His diagnosis in effect split *Neoschöngastia*.

In 1939 Womersley proposed a new genus, *Paraschöngastia* (type species *Neoschöngastia yeomansi* Gunther, 1939, by subsequent designation in Womersley and Heaslip, 1943), for a group of four species within *Neoschöngastia*.

Vitzthum (1942) considered *Euschöngastia* as a subgenus of *Schöngastia*, but subsequent authors have retained it as a full genus.

Ewing (1946b) showed that the four species placed in *Paraschöngastia* by Womersley were congeneric with the type species of *Neoschöngastia*. Therefore, *Paraschöngastia* Womersley, 1939, was a synonym of *Neoschöngastia* Ewing, 1929. Ewing then restricted *Neoschöngastia* to this newly formed group. This action excluded many species formerly in *Neoschöngastia*. To accommodate these excluded species, he erected a new genus, *Ascoschöngastia* Ewing, 1946, type species *Neoschöngastia malayensis* Gater, 1932. Workers outside the United States have followed Ewing's diagnoses of these genera.

However, Wharton (1948) has pointed out that the type species of *Ascoschöngastia* had an unusual morphological feature—the posterolateral setae lying off the scutum—which made it almost

unique. He held that *Ascoshöngastia* should be restricted to species with this character, and he expanded *Euschöngastia* to include all other species formerly placed in *Ascoshöngastia*. Fuller (1948) followed Wharton's concept and placed in *Euschöngastia* a number of old species, including *E. trouessarti*. In 1950 Ewing split off the monotypic genus *Boshellia* (type species *Neoschöngastia hirsuta* Boshell and Kerr, 1942). Recently, Fuller (1952), along with a list of the known species, gave a more complete diagnosis of the genus, which is accepted for this paper.

DISTRIBUTION: The genus *Euschöngastia* is widely distributed over the world. It has been found wherever collections have been made. In Ewing's original description only the genotype, *E. americana*, was included. Fuller (1948, 1952) has assembled most of the known species which were described originally under other generic names. Also, he has synonymized certain species with *E. indica*. Brennan (1947, 1948) described new species from North America. Recent *Ascoshöngastia* species of Lawrence (1949) from Africa are placed here in *Euschöngastia*. *Boshellia* Ewing, 1950, is here considered a synonym of *Euschöngastia*. If *Euschöngastia* later is split into subgenera, *Boshellia* will probably be valid at that level. All species are brought together in the following list, which summarizes by geographic regions the species of *Euschöngastia* described at the present time:

AUSTRALIA-ASIA

- E. antipodianum* (Hirst), Proc. Zool. Soc. London, vol. 12, pp. 175-176, figs. 6,c,f, 7,e,f, 1929.
 Locality: South Australia.
 Type host: *Rattus greyi* (Gray).
- E. bushlandi* (Philip), Journ. Parasit., vol. 33, pp. 387-390, figs. 1, 2, 1947.
 Locality: Dutch New Guinea.
 Type host: Bush fowl (*Megapodius*).
 Holotype: U. S. National Museum No. 1780.
- E. cairnsensis* (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 108, 125, 128-129, pl. 10, fig. 7, text figs. 17A,B, 1943.
 Locality: Queensland, Australia.
 Type host: Rats.
- E. cairnsensis* var. *gateri* (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 108, 125, 129, pl. 10, fig. 8, 1943.
 Locality: Queensland, Australia.
 Type host: Rats.
- E. dasycerci* (Hirst), Proc. Zool. Soc. London, vol. 12, pp. 174-175, text figs. 6B,E, 7A,B,D, 1929.
 Locality: South Australia.
 Type host: *Dasycercus cristicauda* (Krefft).

- E. debilis* (Gater), Parasitology, vol. 24, pp. 160-161, fig. 6, 1932.
Locality: Federated Malay States.
Type host: *Rattus cremoriventer cremoriventer* (Miller).
Holotype (only): British Museum.
- E. derricki* (Womersley), Trans. Roy. Soc. South Australia, vol. 63, pp. 162-163, fig. 9A-E, 1939.
Locality: Queensland, Australia.
Hosts: *Rattus lutreolus* (Gray) and *R. assimilis* (Gould).
- E. echymipera* (Womersley and Kohls), Trans. Roy. Soc. South Australia, vol. 71, pp. 11-12, figs. 6A-C, 1947.
Locality: New Guinea.
Type host: *Echymipera cockerelli* (Ramsay).
- E. edwardsi* (Gunther), Proc. Linn. Soc. New South Wales, vol. 64, pp. 73, 82, 84, 86-87, figs. 13, 18, 26, 1939.
Locality: New Guinea.
Hosts: Bush fowl (*Megapodius duperreyi*) and bandicoot (*Echymipera cockerelli* (Ramsay)).
Type slide: School of Public Health and Tropical Medicine, University of Sidney.
- E. foliata* (Gunther), Proc. Linn. Soc. New South Wales, vol. 65, pp. 251, 255-257, figs. 9-11, 1940.
Locality: New Guinea.
Type host: Scrub wallaby (*Macropus* [= *Thylogale*] *coxenii* (Gray)).
Type slide: School of Public Health and Tropical Medicine, University of Sidney.
- E. globulare* (Walch), Geneesk. Tijdschr. Nederlandsch-Indië, vol. 67, pp. 929-930, 1927 [*fide* Sig Thor and Willmann, Das Tierreich, Acarina 3, Lief. 71b, p. 305, 1947].
Locality: Celebes.
Type host: Rats.
- Neoschöngastia guntheri* Womersley and Heaslip, Trans. Roy. Soc. South Australia, vol. 67, pp. 125, 126-127, pl. x, fig. 4, text fig. 15 A-B, 1943 (= *Euschöngastia laurencei* (Womersley, 1952)). Not *Neoschöngastia guntheri* Radford, Parasitology, vol. 34, pp. 76, 77, fig. 101, 1942.
Locality: Queensland, Australia.
Type host: Rats.
- E. heaslipi* (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 108, 119-121, pl. ix, fig. 6, text fig. 12A-E, 1943.
Locality: Queensland, Australia.
Type host: Rats.
- E. hirsti* (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 108, 123, 125, pl. 10, fig. 1, text figs. 13A,B, 1943.
Locality: Queensland, Australia.
Hosts: Rats and *Melomys cervinipes* (Gould).
- E. indica* (Hirst), Bull. Ent. Res., vol. 6, pp. 187-188, figs. 5,6, 1915.
Locality: Calcutta, India.
Type host: *Nesokia* [= *Bandicota*] *bengalensis* (Gray and Hardwicke).
Synonyms: *Trombicula muris* Walch, Geneesk. Tijdschr. Nederlandsch-Indië, vol. 64, p. 502, figs. 13-17, 1922 [*fide* Sig Thor and Willmann,

Das Tierreich, Acarina 3, Lief. 71b, p. 301, 1947]. *Neoschöngastia rattus* Womersley and Heaslip, Trans. Roy. Soc. South Australia, vol. 67, pp. 108, 118–120, pl. 9, fig. 5, text figs. 11A,B, 1943. *Neoschöngastia cockingsi* Radford, Proc. Zool. Soc. London, vol. 116, p. 262, figs. 25,26, 1946.

E. innisfailensis (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 107, 108–109, pl. 7, fig. 1, text figs. 9 A–B, 1943.

Locality: Queensland, Australia.

Type host: *Melomys littoralis* (Lönnberg).

E. kohlsi (Philip and Woodward), Amer. Journ. Trop. Med., vol. 26, pp. 159–161, 1946.

Locality: Mindoro, Philippine Islands.

Type host: *Rattus mindanensis mindanensis* (Mearns).

Type slide: U. S. National Museum No. 1526.

E. lacunosa (Gater), Parasitology, vol. 24, pp. 156–158, fig. 6, 1932.

Locality: Federated Malay States.

Type host: *Rattus sabanus vociferans* (Miller).

Type slide: British Museum.

Paratypes: U. S. National Museum.

E. lanius (Radford), Proc. Zool. Soc. London, vol. 116, pp. 261–262, figs. 23, 24, 1946.

Locality: Imphal, India.

Type host: Black-headed shrike (*Lanius nasutus* Scopoli).

E. lorius (Gunther), Proc. Linn. Soc. New South Wales, vol. 64, pp. 73, 82, 84, 86, figs. 12, 17, 25, 1939.

Locality: New Guinea.

Type host: Parrot (*Lorius roratus* subspecies).

Type slide: School of Public Health and Tropical Medicine, University of Sidney.

E. mccullochi (Womersley), Trans. Roy. Soc. South Australia, vol. 68, pp. 99–100, fig. 7 A–E, 1944.

Locality: New Guinea.

Type host: None. A single specimen collected on boots.

E. melomys (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 107, 110–111, pl. 7, fig. 3, text figs. 10A,B, 1943.

Locality: Queensland, Australia.

Type host: *Melomys littoralis* (Lönnberg).

E. mutabilis (Gater), Parasitology, vol. 24, pp. 159–160, 1932.

Locality: Federated Malay States.

Type host: *Rattus sabanus vociferans* (Miller).

Type slide: British Museum.

Paratypes: U. S. National Museum.

E. perameles (Womersley), Trans. Roy. Soc. South Australia, vol. 63, pp. 160–162, figs. 7A–E, 1939.

Locality: Queensland, Australia.

Type host: Bandicoots.

E. petrogale (Womersley), Rec. South Australian Mus., vol. 5, pp. 215–217, figs. 92–95, 1934.

Locality: Musgrave Ranges, South Australia.

Type host: Wallaby.

- E. phascogale* (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 108, 127-128, pl. 10, fig. 6, text figs. 16A,B, 1943.
Locality: Queensland, Australia.
Type host: *Phascogale* sp.
- E. philippensis* (Philip and Woodward), Amer. Journ. Trop. Med., vol. 26, pp. 158-159, 1946.
Locality: Mindoro, Philippine Islands.
Type host: *Rattus mindanensis mindanensis* (Mearns).
Type slide: U. S. National Museum No. 1525.
- E. queenslandica* (Womersley), Trans. Roy. Soc. South Australia, vol. 63, pp. 161-162, figs. 8A-E, 1939.
Locality: Queensland, Australia.
Hosts: *Rattus assimilis* (Gould), *R. youngi* Thomas, *R. lutreolus* (Gray), and *Melomys cervinipes* (Gould).
- E. shieldsi* (Gunther), Proc. Linn. Soc. New South Wales, vol. 66, pp. 157, 158-159, figs. 4, 5, 1941.
Locality: New Guinea.
Type host: Rufous scale-tail rat (*Melomys rubex* Thomas).
Type slides: School of Public Health and Tropical Medicine, University of Sidney.
- E. similis* (Womersley and Heaslip), Trans. Roy. Soc. South Australia, vol. 67, pp. 108, 124, pl. 10, fig. 2, text figs. 14A,B, 1943.
Locality: Queensland, Australia.
Type host: Rats.
- E. smithi* (Womersley), Trans. Roy. Soc. South Australia, vol. 63, pp. 164, 165, figs. 10A-E, 1939.
Locality: Queensland, Australia.
Type host: *Rattus assimilis* (Gould).
- E. trichosuri* (Womersley), Trans. Roy. Soc. South Australia, vol. 63, pp. 159-160, 165, figs. 6A-E, 1939.
Locality: Queensland, Australia.
Type host: *Trichosurus vulpecula* (Kerr).
- E. uromys* (Womersley and Kohls), Trans. Roy. Soc. South Australia, vol. 71, pp. 10-11, figs. 5A-E, 1947.
Locality: New Guinea.
Type host: *Uromys lamington* Troughton.
- E. westraliense* (Womersley), Rec. South Australian Mus., vol. 5, p. 215, figs. 90, 91, 1934.
Locality: Greenbushes, West Australia.
Type host: Cat.
- E. womersleyi* (Gunther), Proc. Linn. Soc. New South Wales, vol. 65, pp. 251, 253, 254-255, figs. 6-8, 1940.
Locality: New Guinea.
Type host: Scrub wallaby (*Macropus* [= *Thylogale*] *coxenii* (Gray)).
Type slide: School of Public Health and Tropical Medicine, University of Sidney.
- AFRICA
- E. aethomyia* (Radford), Parasitology, vol. 34, pp. 76, 78, fig. 102, 1942.
Locality: Bathurst, South Africa.
Type host: Graham's rock mouse (*Aethomys namaquensis grahami* (Roberts)).

- E. annulata* (Lawrence), Ann. Natal Mus., vol. 11, pp. 414-415, 465, 471, 482, text figs. 4a,b, 5a-c, 1949.
Locality: Transvaal.
Type host: Elephant shrew (*Elephantulus myurus jamesoni* Chubb).
- E. brevipalpis* (André), Bull. Mus. Hist. Nat. Paris, vol. 18, pp. 162-164, figs. 1-3, 1946.
Locality: Carthage, Tunis.
Type host: *Meriones shawi* (Rozet [= Duvernoy]).
- E. capensis* (Lawrence), Ann. Natal Mus., vol. 11, pp. 438, 465, 471, 484, text figs. 24a-c, 1949.
Locality: Cape Province.
Type host: *Eremias lineo-ocellata pulchella*.
- E. crociduræ* (Lawrence), Ann. Natal Mus., vol. 11, pp. 416-417, 465, 471, 482, text figs. 6a-c, 1949.
Locality: Natal.
Type host: Shrew (*Crocidura flavescens* (Geoffroy)).
- E. gerrhosauri* (Lawrence), Ann. Natal Mus., vol. 11, pp. 433-434, 465, 472, 483, text figs. 19a-c, 1949.
Locality: Orange Free State.
Type host: *Gerrhosaurus flavigularis flavigularis* Gray.
- E. kalaharica* (Lawrence), Ann. Natal Mus., vol. 11, pp. 434, 465, 472, 484, text figs. 20a-c, 1949.
Locality: Kalahari.
Type host: *Ichnotropis squamulosa* Peters, 1854.
- E. matoppoanus* (Lawrence), Ann. Natal Mus., vol. 11, pp. 435-436, 465, 471, 483, 484, text figs. 22a-c, 1949.
Locality: South Rhodesia.
Type host: *Platysaurus guttatus rhodesiensis*.
- E. ophicola* (Lawrence), Ann. Natal Mus., vol. 11, pp. 461, 465, 472, 484, text figs. 46a-c, 1949.
Locality: Natal.
Type host: House snake (*Boaedon lineatus*).
- E. origensis* (Lawrence), Ann. Natal. Mus., vol. 11, pp. 431-432, 465, 472, 484, text figs. 17a-c, 1949.
Locality: Natal.
Type host: *Tropidosaura essexi*.
- E. otomyia* (Radford), Parasitology, vol. 34, pp. 76, 77, fig. 100, 1942.
Locality: South Africa.
Type host: Swamp rat (*Otomys tugelensis pretoriae* Roberts).
- E. rhodesiensis* (Lawrence), Ann. Natal Mus., vol. 11, pp. 437, 465, 472, 483, text figs. 23a-c, 1949.
Locality: Southern Rhodesia.
Type host: *Mabuya 5-taeniata margaritifera*.
- E. transvaalensis* (Lawrence), Ann. Natal Mus., vol. 11, pp. 435, 465, 472, 484, text figs. 21a-c, 1949.
Locality: Transvaal.
Type host: *Ichnotropis squamulosa* Peters.
- E. tropidosauri* (Lawrence), Ann. Natal Mus., vol. 11, pp. 432-433, 465, 472, 484, text figs. 18a-c, 1949.
Locality: Natal.
Type host: *Tropidosaura essexi*.

E. viperina (Lawrence), Ann. Natal Mus., vol. 11, pp. 462, 465, 472, 484, text figs. 47a-c, 1949.

Locality: Pietermaritzburg.

Type host: Night adder (*Causus rhombeatus*).

EUROPE

E. xerothermobia (Willmann), Zeitschr. Parasitenk., vol. 12, pp. 643-644, 1942.

Locality: Graz, Steiermark, Austria.

Host: Unknown.

MÉXICO

E. nuñezi (Hoffmann), Rev. Inst. Sal. Enf. Trop., vol. 5, pp. 221-225, figs. 1-4, 1944.

Locality: México.

Host: Man.

Type slide: Instituto de Salubridad y Enfermedades Tropicales de México.

SOUTH AMERICA

E. dasyproctae (Ewing), Proc. Biol. Soc. Washington, vol. 50, p. 168, 1937.

Locality: Colombia.

Type host: Agouti (*Dasyprocta variegata* Tschudi).

Type slide: U. S. National Museum No. 1260.

E. columbiae (Boshell and Kerr), Rev. Acad. Colombiana Cienc. Exact. Fis. Nat., vol. 5, pp. 7, 16, 18, pl. 10, figs. 6-8, 1942.

Locality: Colombia.

Type host: *Proechimys chrysaolus* (Thomas).

E. guyanensis (Floch and Abonnenc), Publ. Inst. Pasteur Guyane Terr. l'Inini, vol. 20, pp. 2, 13-16, fig. 5, 1941.

Locality: French Guiana.

Hosts: Dog and man.

Type slide: Institut Pasteur de la Guyane et du Territoire de l'Inini No. 158.

E. hirsuta (Boshell and Kerr), Rev. Acad. Colombiana Cienc. Exact. Fis. Nat., vol. 5, pp. 7, 19, pl. 1, figs. 4, 5, 1942.

Locality: Colombia

Type host: *Proechimys chrysaolus* (Thomas).

Type slide: U. S. National Museum No. 53018.

E. nasuae (Boshell and Kerr), Rev. Acad. Colombiana Cienc. Exact. Fis. Nat., vol. 5, pp. 7, 19-20, pl. 1, figs. 1-3, 1942.

Locality: Colombia.

Type host: *Nasua candace* Thomas.

Type slide: U. S. National Museum No. 53019.

E. phylloti Wharton, Psyche, vol. 55, pp. 89, 90-92, 99, figs. 1 A-H, 1948.

Locality: Caccachara, Perú.

Type host: *Phyllotis darwini* (Waterhouse).

Type slide: Museum of Comparative Zoology No. 3026.

E. trouessarti (Oudemans), Ent. Ber., Amsterdam, vol. 3, p. 87, 1910 [*vide* Sig Thor and Willmann, Das Tierreich, Acarina 3, Lief. 71b, p. 311, 1947].

Locality: Southern Brazil.

Type host: *Didelphis* [= *Philander*] *opossum* Linnaeus.

UNITED STATES

- E. blarinae* (Ewing), Proc. U. S. Nat. Mus., vol. 80, pp. 11-12, 19, pl. 1, fig. 1, 1931.
Locality: Rock Creek Park, Washington, D. C.
Type host: *Peromyscus leucopus* (Rafinesque).
Type slide: U. S. National Museum No. 1018.
- E. californica* (Ewing), Amer. Journ. Trop. Med., vol. 5, pp. 261, 262, 1925.
Locality: Topaz, Calif.
Type host: Ground squirrel.
Type slide: U. S. National Museum No. 893.
- E. cordiremus* Brennan, Journ. Parasitol., vol. 34, pp. 465, 470, 471, 477, figs. 4A-D, 11, 1948.
Locality: Ravalli County, Mont.
Type host: *Peromyscus maniculatus artemisiae* (Rhoads).
Type slide: Rocky Mountain Laboratory.
- E. criceticola* Brennan, Journ. Parasitol., vol. 34, pp. 465, 473-474, 476, 477, figs. 6A-D, 13, 1948.
Locality: Ravalli County, Mont.
Type host: *Peromyscus maniculatus artemisiae* (Rhoads).
Type slide: Rocky Mountain Laboratory.
- E. guntheri* (Radford), Parasitology, vol. 34, pp. 76, 77, fig. 101, 1942.
Locality: Antonito, Colo.
Type host: Cony [*Ochotona*].
- E. hamiltoni* Brennan, Journ. Parasitol., vol. 33, pp. 251-252, figs. 4A-D, 1947.
Locality: Millertown, N. Y.
Type host: *Eptesicus fuscus fuscus* (Beauvois).
Type slide: Rocky Mountain Laboratory.
- E. lacerta* Brennan, Journ. Parasitol., vol. 34, pp. 465, 467-468, 477, figs. 2A-D, 9, 1948.
Locality: Camp McQuaide, Santa Cruz County, Calif.
Type host: *Sceloporus occidentalis occidentalis* (Baird and Girard).
Type slide: Rocky Mountain Laboratory.
- E. luteodema* Brennan, Journ. Parasitol., vol. 34, pp. 465, 470, 472-473, 477, figs. 5A-D, 12, 1948.
Type locality: Ross's Hole, Ravalli County, Mont.
Type host: *Marmota flaviventer nosophora* Howell.
Type slide: Rocky Mountain Laboratory.
- E. oregonensis* (Ewing), Proc. Ent. Soc. Washington, vol. 31, p. 11, 1929.
Locality: Corvallis, Oreg.
Type host: Mole.
Type slide: U. S. National Museum No. 990.
- E. peromysci* (Ewing), Ent. News, vol. 40, pp. 296-297, 1929.
Locality: Sturbridge, Mass.
Type host: *Peromyscus leucopus noveboracensis* (Fischer).
Type slide: U. S. National Museum No. 993.
Synonyms: *Neoschöngastia brevipes* Ewing, Proc. U. S. Nat. Mus., vol. 80, art. 8, pp. 16, 19, pl. 2, fig. 4, 1931. *Neoschöngastia signator* Ewing, Proc. U. S. Nat. Mus., vol. 80, art. 8, pp. 14-15, 19, pl. 2, fig. 1, 1931.

- E. pipistrelli* Brennan, Journ. Parasitol., vol. 33, pp. 249-251, figs. 3A-D, 1947.
Locality: Mud Cave, Stone County, Mo.
Type host: *Pipistrellus subflavus subflavus* (F. Cuvier).
Type slide: Rocky Mountain Laboratory.
Synonym: *E. miricoxa* Brennan, Journ. Parasitol., vol. 34, pp. 465, 468-469, 477, figs. 3A-E, 10, 1948.
- E. samboni* (Radford), Parasitology, vol. 34, pp. 76-77, fig. 99, 1942.
Locality: Ross's Hole, Mont.
Type host: *Pika* [*Ochotona*].
- E. sciuricola* (Ewing), Amer. Journ. Trop. Med., vol. 5, pp. 261, 262, 1925.
Locality: Florence, Mont.
Type host: *Sciurus* [= *Tamiasciurus*] *hudsonicus richardsoni* Bachman.
Type slide: U. S. National Museum No. 892.
Synonym: *E. americana* Ewing, Journ. Washington Acad. Sci., vol. 28, p. 293, 1938.
- E. setosa* (Ewing), Proc. Biol. Soc. Washington, vol. 50, pp. 170, 171, 1937.
Locality: Okefenokee Swamp, Ga.
Type host: *Peromyscus gossypinus gossypinus* (LeConte).
Type slide: U. S. National Museum No. 1256.

CULTURE AND LIFE HISTORY: Knowledge of the life history of trombiculid mites has been acquired mostly by rearing them in the laboratory. The Japanese were the first active workers on chigger culture. During the early years of this century, they were trying to determine the development of the vector of tsutsugamushi disease. However, the first report of rearing chiggers was that of Kneissl (1916), who obtained nymphs in a culture jar with soil from engorged larvae of *Trombicula autumnalis*. The next year, 1917, Miyajima and Okumura reared *T. akamushi* through all its life cycle. They described and figured the deutovum, larva, nymphochrysalis, nymph, imagochrysalis, and adult, but they failed to find the egg. They used soil in jars for their cultures, apparently, and gave the nymphs and adults pieces of potato and mellon as food. Hatori (1919) described rearing engorged chiggers through the adult stage in vitro with soil, but attempts to culture them on vegetable matter in vitro failed. Ewing (1925a) reported the first effort at rearing chiggers in the United States. He obtained larvae from a wild-caught female *Trombicula alfreddugèsi* (Oudemans, 1910) which he kept on a disc of cork placed on sand in a vial. Springtail fecal pellets and a dead springtail were offered as food. Miller (1925a, 1925b) reported obtaining adults of *T. alfreddugèsi* from engorged larvae shed from infested snakes kept in suitable "aquaria" with soil. However, Ewing (1944b) stated that Miller reared nymphs, not adults. Ewing (1926a) reared 28 nymphs and two adults of

T. alfreddugèsi from chiggers of four infested Carolina terrapins. The terrapins were placed in containers with sand on the bottoms. The chiggers detached easily. One nymph was placed in a small cell with cockroach feces. It died after 31 days without transforming. Ewing (1926b) obtained many nymphs and a single adult of *Hannemania hylae* (Ewing, 1925), subfamily Leeuwenhoeekiinae, from engorged larvae in soil on which their tree frog hosts had been kept. He described the nymph and adult and figured all three active stages. André (1930) reported rearing a nymph of *T. autumnalis*. Keay (1937) reared a "considerable number" of nymphs from fully engorged *T. autumnalis* larvae placed in sterilized soil in an atmosphere saturated with moisture. Nymphs were obtained by Gunther (1939b) from engorged *Trombicula* sp. larvae placed in jars with moist, sterile soil. In 1944 Ewing (1944b) reported having reared nymphs of *T. alfreddugèsi* from larvae engorged on toads. At this time he summarized the life cycle of this species as it was known—the egg removed from the abdomen of an adult female, the larva, the nymph, and the adult.

The first successful culturing of chiggers in which reproduction occurred and subcultures were established was reported by Melvin (1946) and Michener (1946), working with *T. batatas* (Linnaeus, 1758). They worked in the same laboratory and their methods were similar. Both used baby chicks as hosts for the larvae. Engorged larvae were placed in bottles or jars containing soil mixed with chicken manure in which the mites completed their development. No food was offered in addition to the chicken manure-soil mixture. Michener described and figured the seven stages of the life cycle.

None of these workers determined the food requirements of the free-living stages. Then Wharton (1946) and Wharton and Carver (1946), working with *Euschöngastia indica*, discovered that insect eggs were suitable food for the nymphs and adults. The feeding process was observed with a dissecting microscope. *Drosophila*, *Culex*, and *Aedes* eggs and the eggs of other species were used. Adults were observed, also, to feed on their own eggs and on ant larvae. What appeared to be an unsuccessful attempt at cannibalism by one nymph upon another was seen once. Nymphs and adults were obtained from engorged larvae, and these reared adults produced larvae. Wharton (1946) gave descriptions of all stages, figures of egg, deutovum, larva, nymphochrysalis, and nymph, and photographs of all stages except the egg. After the discovery of insect eggs as food for the free-

living nymphs and adults, culturing of trombiculids was much facilitated.

Jenkins (1947) published a method, incorporating the results of other workers, by which three species of *Trombicula* had been cultured successfully. He used terrapins and snakes as hosts for larvae, soil as a medium, and mosquito eggs as food for nymphs and adults. Jayewickreme and Niles (1947) outlined a method which employed cellulose wadding as a medium, mice as hosts for larvae, and *Culex* eggs and freshly killed collembolans as food for the free-living stages. Farrell and Wharton (1949) featured an improved culture jar, golden hamsters as hosts, and vermiculite as a medium. The most recent information on culturing was by Lipovsky (1951). He reported having reared about 25 species of trombiculids to the adult stage. He obtained larvae from about 15 species of these reared adults. The species were not named but were stated to represent six known genera, including *Euschöngastia*, and two undescribed genera. In Lipovsky's method a collembolan, *Sinella curviseta* Brook, fed on active dried yeast pellets was maintained in the chigger cultures. The nymphal and adult trombiculids fed on the collembolan eggs or the active stages of the insect.

ECOLOGY AND BEHAVIOR: Literature concerned directly with the ecology and behavior of trombiculids is scant. Much ecological information has been acquired in the basic collection data accompanying all specimens and their descriptions. These data consist of locality, date, and host. Occasionally notes have been added which state the areas infested on the host. Other valuable information, including the fundamental details of life history and food requirements, has come from the efforts to culture chiggers.

Riley (1873) gave one of the first ecological notes on pest chiggers of the United States. He said their habitat was rank herbage and grass in forest openings or along streams. He stated that chiggers bury themselves in the skin and that "The normal food . . . of these mites must, apparently, consist of the juices of plants, and the love of blood proves ruinous to those individuals which get a chance to indulge it They soon die—victims of their sanguinary appetite." Riley repeated these comments in 1887. Chittenden (1915) associated pest chiggers with briar patches and gave a life cycle which omitted the nymph. He confused chiggers with arthropod-infesting trombidids. He stated chiggers burrow under the skin and apparently gorge with blood. In 1915 Banks gave a brief account of pest chiggers, listing common names. He said, "They enter pores of the skin and pro-

duce inflamed spots. It is an unnatural situation for the mites and they soon die." Howard (1918) said that chiggers do not bury themselves when engorging but insert mouthparts and fill with blood, and after engorging fall off.

Ewing (1921) gave an account of early investigations on geographic and seasonal distribution, habitat preference, manner of attaching to human skin, and related topics. The normal hosts were not known. Ewing tried to find chiggers feeding on plants, although he did not believe they used plant food. His efforts to find them on insects and small mammals failed also. He found many attached to a shed snakeskin from which they were unable to free themselves, and he concluded snakes were not normal hosts. He described and figured chiggers attached to the surface of human skin, and said they fed on lymph of the "true skin." Miller (1925a and 1925b) showed snakes to be normal hosts. Ewing (1926a) found the Carolina terrapin to be an important host; and later he (1929b) added the rabbit and several species of birds to the list.

Keay (1937), clearly making a study of the ecology of *Trombicula autumnalis*, determined something of its seasonal distribution and host preferences. She found its local distribution sporadic but was unable to determine limiting factors in vegetation or soil, although most records were from calcareous soil. Buxton (1945) made similar comments on the natural history of this species.

In 1943, *Acomatacarus paradoxa* (André) Brennan, 1949, was described from scorpion, an exception to Ewing's ecological diagnosis of the family Trombiculidae.

Much information has been assembled by the groups working with scrub typhus. Blake, Maxcy, et al. (1945) gave an account of the habits of free and attached chiggers, the results of studying several species in New Guinea. Mackie, Davis, et al. (1946), in Assam and Burma, found some evidence of seasonal activity of the mites in relation to rains by using the number of cases of the disease as an index. Audy (1947a) pointed out the localized distribution of *T. deliensis* Walch, 1922, could have been the result of ecological demands by the free-living stages. He stated the mites were not conspicuous around the burrows of their rat hosts but were most abundant in "fringe habitats," the intermediate areas between forest and open scrub. During dry seasons he found the chiggers only in moist areas, but the populations increased greatly after the onset of the rains. Audy (1947b) reemphasized the peak incidence of *T. deliensis* larvae during the

rains and pointed out the importance of their principal hosts in their patchy distribution.

Wharton (1946) found the adults of *Euschöngastia indica* living in the nests of rats in trees and on the ground. The rats were parasitized by the larvae. Wharton studied the biological factors of the environment and gave lists of associated organisms. Jenkins (1948a) gave an account of three species of *Trombicula* which affect man in the United States, with data on seasonal activity, distribution, habitat preference, hosts, and life cycle included.

Cockings (1948), in giving methods for collecting free larvae of *T. autumnalis* in the field and for recovering engorged larvae from hosts, indicated the larvae reacted positively to light. Also, he made observations on the vertical distribution of the adults in the soil and found a correlation with temperature and rainfall. Jenkins (1948b) made laboratory investigations of the reactions of larvae of *T. alfreddugèsi* and *T. splendens* Ewing, 1913, to various physical factors. He found activity to be initiated in the chiggers by disturbances in the environment. The direction of movement appeared to be determined by light. The reaction was positive for previously dark-conditioned larvae and negative for previously light-conditioned larvae. The rate of movement was determined primarily by temperature.

MEDICAL IMPORTANCE: There is considerable literature on *Trombicula* which attack man but very little on *Euschöngastia* which attack man. Floch and Abonnenc (1941) stated that *E. guyanensis* was a parasite on man. Hoffmann (1944) described *E. nuñezi* from human hosts. Nuñez (1947) gave a full account of the six cases of trombidiasis in one family from which Miss Hoffmann's specimens were collected.

DESCRIPTION REVIEW: The manner of describing chiggers has fluctuated somewhat as different workers have stressed various characters. Oudemans (1912) gave a good description of the whole mite, including some of the specialized setae of the legs. Later descriptions frequently were less adequate. In 1925 Ewing (1925b) emphasized the palpal setae, in 1937 he emphasized the dorsal setae of the body, and in 1938 he used the branches on the palpal claw to separate genera. Gunther (1940) noted unusual body setae. Methlagl (1927) used two formulas—the convexity factor and the ratio of length to width—to describe scuta, but other workers have not followed his method. Womersley and Heaslip (1943) introduced a series of measurements of the

scutum, the Standard Data. Directions for photomicrography of the scutum and the whole mite were given by Gill and Parrish (1945). Wharton (1947a) outlined the development of chigger description and presented his method of recording morphological units in a series of drawings; and in 1948 he called attention to the value of the specialized setae of the legs in grouping and identifying species of chiggers. Wharton, Jenkins, et al. (1951) contributed a list of characters useful in descriptions of both larvae and adults, with a glossary of terms. Through the years most workers have used drawings to supplement their written descriptions.

Materials and methods

The chiggers collected in the Duke Forest area for this study were taken mostly from infested small mammal hosts which were trapped during a program extending from September 1947 to December 1949. When transportation facilities permitted, traps were set on Saturday afternoon of each week and were picked up early on Sunday morning. During Christmas and spring vacations, trapping usually was continuous and traps were visited each morning. Areas to be trapped were determined by reference to the Forest Cover Maps published by the Duke University School of Forestry on July 1, 1944. The system of compartment identification used on these maps has been followed in this paper.

Museum special snap traps, supplemented by one or two ordinary rat traps, made up the standard trap line. The number of traps set varied, but it was usually about 35. The bait generally used was oatmeal moistened with saliva and pressed on the trigger. Two types of box traps were used infrequently—a single trap with a drop door, baited with apple or carrot, for rabbits, and several box traps with inward swinging hardware cloth doors, baited with oatmeal or carrot, for mice. On two occasions lines of steel traps were run continuously to collect fur bearers. One line was kept out for eight days in February 1949. A second line was operated for 16 days in November and December 1949. A shotgun was used to collect squirrels, rabbits, and bats; small mammal highway casualties were picked up; and gifts of vertebrates were accepted from other workers in the area.

No organized collecting was done for vertebrates other than mammals, but they were collected occasionally. Reptiles, particularly, were collected whenever opportunity offered.

Trapped mammals were examined immediately for ants, which were removed. All specimens except fur bearers were then placed in No. 3 or No. 5 paper bags. The mouth of the bag was closed by twisting the paper tightly. Specimens were separated as to locality and species during the winter months. Usually, in late spring, summer, and fall each specimen was placed in a separate bag. Fur bearers were placed in burlap or cloth bags or were taken to the laboratory uncovered.

In the laboratory the paper bags and the specimens were examined for chiggers. The bags were torn open, smoothed out, and inspected with hand lens or dissecting microscope. The mammals were examined with the aid of the hand lens or the dissecting microscope, with particular attention being given to the ears in all species and to the posterior portion of the venter and the rump on shrews. Chiggers often were found crawling on the fur.

Some chiggers were removed directly from their places of attachment by use of a dissecting needle, but it was preferred to permit them to free themselves. At the beginning of the second winter's trapping, it became standard routine first to examine the hosts visually and to remove chiggers already detached. Hosts not preserved and freshly prepared study skins were then placed on wire screens in funnels over water. This was an adaptation of the Berlese funnel. A low rack was made which held seven funnels. Glass and metal funnels of standard shape and funnels with straight sides were used. These funnels were 20 to 24 cm. in diameter. Screens of hardware cloth were cut to fit about 2.5 cm. inside the funnels. Beakers, finger bowls, and the bottoms of weighing bottles half filled with water were placed under the funnels to receive the chiggers when they detached. To prevent migration of chiggers between funnels and between collecting dishes, benzol benzoate was applied to the rack between the funnels and to squares of insulation board on which the collecting dishes were placed. A bent dissecting needle was used to pick up chiggers. To be effective in removing chiggers from fur or paper, the tip of the needle was moistened with water.

Chiggers which were to be used alive, if not immediately, were placed in special vials (Farrell and Wharton, 1948) made by lining 25 x 15 mm. shell vials with a mixture of plaster of Paris 90 parts by weight and activated charcoal 10 parts by weight. Stoppers were smooth No. 4 corks. The lining was kept moist with distilled water. Chiggers to be preserved were mounted

directly on slides or were stored in small glass tubes in 85 percent ethyl alcohol.

Records were kept of hosts and chiggers by collections. A collection of hosts consisted of all host specimens of one species taken in one locality on one date. A collection of chiggers consisted initially of all chiggers taken from one collection of hosts. Later, the separate species of chiggers were identified. The number of individual hosts infested was determined for each collection by direct examination or by recovering chiggers over water; but chiggers were identified from collections of hosts, not from the separate host specimens. In Duke Forest a compartment was considered a locality. If a single trap line extended through two compartments, it was considered to lie in one locality unless a stream separated the compartments. In the latter case the line was considered to lie in two localities. Outside Duke Forest, streams or main highways were considered to be boundaries separating the localities.

Unattached chiggers were collected through Berlese funnels from soil and other materials from various ecological niches. A battery of four funnels, each 48 cm. wide by 58 cm. high, was used. A rack supporting four electric lamps in large reflectors was constructed to supply top heat for drying the materials placed on the funnels. Small beakers and bottoms of weighing bottles were half filled with water and placed under the funnels to receive the organisms. The glassware rested on squares of insulation board swabbed with benzol benzoate. Unattached chiggers obtained through Berlese funnels were handled in the same manner as chiggers from hosts.

Chiggers contributed by collectors working on other projects usually were shipped alive to the laboratory in the special charcoal-lined vials. The most extensive of these collections were those of the Pennsylvania Mammal Survey, which continued throughout the year. However, these collectors generally made shipments only when infestations on mammalian hosts were highest.

Living chiggers were used extensively in efforts to establish cultures. Eighty-three cultures of *Euschöngastia* were started. A variety of containers were tried. Standard pint canning jars and tall 12-ounce bottles were tried with bottoms removed and the openings filled with a mixture of plaster of Paris 90 parts by weight and Merck's animal charcoal 10 parts by weight. In use these containers were placed in small finger bowls. Wide-

mouth pint canning jars, jars measuring 140 mm. by 135 mm., weighing bottles, and 4-ounce amber jars were used with bottoms intact. The plaster-charcoal mixture was poured into these, forming a base which varied in thickness from 5 mm. in the weighing bottles to 35 mm. in the larger containers. Some wide-mouth jars were completely lined with the mixture. One weighing bottle and one wide-mouth pint jar were lined with moist cellulose wadding. Some containers were stoppered with cotton plugs, others with solid lids. The plaster-charcoal was kept moist with distilled water to maintain high humidity within the cultures.

Some cultures were established in containers without the addition of media or substrates for the mites. In most cultures some material through which the mites could move was added. Screened soil from forest and open field was used. In earlier cultures a film of animal charcoal was placed on the plaster-charcoal base, and the soil was poured over this. Mixtures of washed sand and soil and stratified sand and soil were tried. Depths of these media varied from 2 or 3 mm. to 50 mm. Some were autoclaved; others were not. Decayed wood from an oak log, leaf mold, and humus were used without autoclaving. Vermiculite was used alone or mixed in equal parts by volume with humus or the debris collected under the bark of a decaying tree.

A variety of foods were tried in an effort to find a kind that the free-living stages would accept. The foods tried were pieces of white potato, pieces of apple, moist fiber from a *Neotoma floridana* (Ord) nest, mouse feces, ground beef, beef liver, flying squirrel flesh, gelatin, ground beef in gelatin, beef liver in gelatin, and pieces of earthworm. Ant larvae, bisected ant pupae, and decapitated *Onychiurus* sp. and termites were offered. A female *Pediculoides* mite producing young was placed in one culture. Other offerings were *Aedes* eggs, *Aedes* eggs sterilized in White's solution (Trager, 1937), *Aedes* eggs ruptured with a needle, dissected *Aedes* eggs and ovaries, *Culex* eggs, ruptured *Culex* eggs, large bug eggs punctured with a needle, dissected grasshopper eggs, spider eggs, eggs dissected from a small fly, dissected soldier beetle eggs, dissected ant ovary, blowfly eggs, crushed blowfly eggs, blowfly maggots hatched in the culture, and May fly eggs. Living *Onychiurus* sp. and other living unidentified apterous insects in variety were placed in cultures. Fresh forest soil with all its contained organisms was used. *Euschöngastia* nymphs were placed in *Trombicula alfreddugèsi*.

cultures which were reproducing. They were placed, also, in a jar with soil in which a deer mouse, infested with mites and fleas, was kept. *Sinella curviseta* Brooks, a collembolan, from Mr. Louis Lipovsky, University of Kansas, was maintained in many later cultures. *Onychiurus* sp. and *S. curviseta*, fed on Brewer's yeast powder, reproduced in cultures, laying numerous spherical eggs.

Most cultures were kept in a darkened cabinet at room conditions. Three were held in an incubator at 30° C., three were kept at 5° to 7.5° C., and one at 10 to 15° C.

To start cultures, engorged larvae usually were held in special vials until they had transformed into nymphs. The vials were flooded with distilled water. The nymphs floated to the top and were transferred by needle into culture jars. Most cultures were inspected at daily to weekly intervals, and food was offered. Distilled water was added, as judged necessary. When cultures were discontinued the jars were flooded with tap water. Dead nymphs were recovered and preserved. Living nymphs were preserved or transferred to other cultures. Identity of nymphs in most cultures was determined by sampling the lot of chiggers from which the nymphs were obtained.

A few living chiggers were used to obtain nymphs of known species. For these determinations, each engorged chigger was placed in a separate special vial. When it had metamorphosed into a nymph, the vial was flooded with water. The nymph and the cast larval skin were picked from the surface of the water. The skin was mounted on a microscope slide and from it the species of the nymph was determined.

Unattached *E. peromysci* from soil were placed on three white mice. The hosts were held in small beakers. Chiggers were removed by dissecting needle from the water surface in the collecting vessels and placed on the fur of the hosts. Hosts were retained about three hours in the beakers and then were put in small cages in funnels over water. When the chiggers detached they were collected from the surface of the water.

A few unattached *E. peromysci* collected from soil were used to determine if they would attach to man. A small hole about 5 mm. in diameter was cut in the center of a piece of adhesive tape measuring 50 mm. by 80 mm. A glass ring, 17 mm. by 5 mm., was placed over the hole on the adhesive side. A piece of fine silk, 30 mm. in diameter, was placed on the glass ring and made concave by finger pressure. A drop of distilled water was placed

in the center of the silk. Two or three chiggers were removed by dissecting needle from the surface of the water in the collecting vessel and floated on the drop of water. The palmar surface of the forearm was placed on top of the assembly, which was secured in place by the adhesive tape. From 4½ to 7 hours later the applications were removed, and the areas were examined with a dissecting microscope.

Chiggers were used in experiments to determine their rates of locomotion during falling and rising temperatures. Two species of chiggers, *T. alfreddugèsi* with a warm weather distribution and *E. peromysci* with a predominantly cold weather distribution, were compared in the tests. Clean glass tubes, 76 mm. or 40 mm. by 7 mm., were used to confine the chiggers. One or two specimens were placed in each tube. The two species were placed in separate tubes. The tubes were stoppered at each end with clean rubber stoppers. An apparatus to produce a slowly falling temperature was made by mixing salt and crushed ice in a trough. A shelf of hardware cloth was suspended in the freezing mixture. A small finger bowl was filled with brine solution and placed on the shelf. The tubes containing the chiggers and the bulb of a thermometer were submerged in the finger bowl. To obtain rising temperatures, the finger bowl was removed from the freezing mixture to room temperature. To produce temperatures above that of the room, hot water from the laboratory supply line was led into the trough by a length of hose; and the finger bowl was returned to the hardware cloth shelf. Light from a dissecting microscope lamp was directed on the chiggers, and a dissecting microscope with an ocular micrometer was used to observe them. The chiggers were timed with a stop watch as they moved through the tubes.

In a second test a dead *Peromyscus leucopus* (Rafinesque), infested with chiggers, was placed in a freezing chamber at -4.5° C. on Mar. 20, 1949. It remained in the chamber at that temperature until it was removed on Apr. 27, 1949, and placed in a funnel over water.

A selective process was used to determine chiggers for preservation on slides. Every effort was made to obtain specimens of all species represented in a collection. Whenever there were many specimens from which a sample was to be mounted on slides, a search was made for different forms. The dissecting microscope was frequently used to examine living material. It was always used with specimens already preserved in alcohol. Any specimens

which appeared different by reason of color, conformation, or number of setae were mounted on slides. Specimens of different engorgements were selected. Chiggers were preserved for study in polyvinyl alcohol with lactic acid on microscope slides.

A Spencer research microscope was used to study the slides. It was equipped with low power and oil immersion apochromatic objective lenses, high dry and oil immersion dark contrast phase contrast objective lenses, and a turret condenser. Compensating oculars of 5x and 10x were used. Each lens system had its own sphere of usefulness. The phase contrast objectives were most helpful for surface detail and body setae in fresh preparations, but in older and overcleared slides were useful for all structures. Drawings and measurements were made with the aid of a reticule carried in one 10x ocular. To be used for measuring, the reticule was calibrated with a stage micrometer. The edge of one square equaled 61.5 microns with the low power apochromatic objective, 14.5 microns with high dry phase, 6.8 microns with the oil immersion apochromatic, and 6.3 microns with the phase oil immersion. Drawings were made on blue-line graph paper ruled to one-fifth of an inch. Photomicrographs were made with a Spencer photomicrographic camera on the microscope. The oil immersion phase contrast lens and a 5x compensating ocular were used for all photomicrographs.

All chigger identifications were made at Duke University. Dr. G. W. Wharton identified two new species of *Trombicula*, the *Trombicula* near *akamushi*, and the new genus. Other chigger identifications were made by the author.

Chiggers of the genus *Euschöngastia* were first sorted out strictly on morphology. A key was developed by which species known in the literature could be identified. Names from the literature were applied temporarily to forms when descriptions seemed to agree with observed morphology. The key was altered and enlarged as the study proceeded. A catalog was kept of all specimens and notes were made of variations and anomalies. After the material had been sorted, each series of specimens was reexamined. If the series was small, all specimens were studied. If the series was large, it was studied by sampling. The sample was taken by picking slides from the slide box at regular intervals. In some cases additional samples were needed from certain geographic areas. They were taken at random from the slide box. More detailed notes, including setal counts and measurements of morphological features were made. Within the limits of the

sample and the methods used, the extent of variation in the selected morphological features was determined for each form. Geographic, seasonal, and host distributions were considered.

Type material was studied at the U. S. National Museum. Cotypes were borrowed from the Museum and paratypes were borrowed from the Rocky Mountain Laboratory. Duke University material was compared with these specimens and valid names were determined for the species already described. Specimens of *Euschöngastia* species which did not occur in the collections assembled at Duke University were studied at the U. S. National Museum or where borrowed from the Museum and the Rocky Mountain Laboratory.

Amount of rainfall and temperatures of the air, soil surface, and subsoil in the Duke Forest area were obtained from a station maintained by Dr. G. W. Wharton on Duke Homestead Road. The temperatures were recorded continuously by a triple record thermograph. On Dec. 18, 1948, the air temperature recorder ceased operating. Air temperatures after that date were obtained from the records of the weather station at the Raleigh-Durham airport. Rainfall was determined by a standard rain gauge. Theses in the Soils Department of Duke University were consulted for moisture content of soils in the forest. Ecological observations were obtained directly from two collectors in other areas who were supplied with blank chigger ecology data forms and lists of hosts from which they had sent chiggers.

Several persons made identifications of material other than chiggers. Miss Grace Gance, of the U. S. National Museum, identified the *Onychiurus* sp. and *Sinella curviseta*. Host identifications of the Pennsylvania Mammal Survey collections were made by Miss Caroline A. Heppenstall and Dr. J. K. Douth, Carnegie Museum, except for the later collections which were identified in the field by the collectors. Dr. F. S. Barkalow, Jr., State College, Raleigh, North Carolina, identified the hosts collected by Mr. Ray Allison in Wake County, North Carolina. Hosts trapped in Ohio and Kentucky by Mr. Woodrow Goodpaster, Cincinnati Museum of Natural History, were identified by the collector. Dr. G. W. Wharton, Duke University, identified certain mammal hosts from which he collected chiggers in Pennsylvania in July 1947. Some of the study skins made of representative mammal hosts collected at Duke University were identified to subspecies by Dr. David H. Johnson, U. S. National Museum. Mr. Kerwin Hyland, Duke University, identi-

fied the salamanders and *Culex quinquefasciatus* Say. Dr. J. R. Bailey, Duke University, identified the garter snakes and the worm snakes. All other identifications of Duke University host material were made to species only by the author.

Specimens of the new species described in this paper are deposited in the following collections: U. S. National Museum (USNM); Duke University (DU); Rocky Mountain Laboratory (RML); Carnegie Museum (CM); Kansas University (KU); South African Museum, Natal (Afr); South Australian Museum, Adelaide (Aus); and C. E. Farrell personal collection (CEF). The Duke University collection has been placed in the U. S. National Museum.

Results

Hosts representing four classes of terrestrial vertebrates were collected in the Duke Forest area during the 28 consecutive months from September 1947 to December 1949 (table 1). Two species of amphibians, seven species of reptiles, 12 species of birds, and 20 species of mammals were included. These hosts were variously parasitized by more than 15 species of chiggers. No *Euschöngastia* was found on amphibians, reptiles, or birds. Seven species of mammals were parasitized by a total of five species of *Euschöngastia* (table 2). The mammalian hosts were *Blarina brevicauda*, *Sciurus c. carolinensis*, *Peromyscus leucopus*, *Peromyscus n. nuttalli*, *Pitymys p. pinetorum*, *Ondatra zibethica*, and *Sylvilagus floridanus mallurus*. The chiggers were *E. peromysci*, *E. rubra*, *E. blarinae*, *E. carolinensis*, and *E. setosa*.

Species of chiggers did not always occur singly in host collections or on individual hosts. In 37 collections of *Peromyscus leucopus* four species of *Euschöngastia* together with two new species of *Trombicula* and a new genus were found in various combinations (table 3). There were 13 of these combinations of species. *E. peromysci* was represented in all. The *E. peromysci*-*E. rubra* association was most frequent; it was common, also, on individual hosts where the white *E. peromysci* could be distinguished easily from the reddish *E. rubra*. In one collection of *Blarina brevicauda* both *E. blarinae* and the new genus were taken.

A number of chiggers other than *Euschöngastia* were removed from hosts collected during this study (table 4). These species represented three known genera—*Hannemania*, *Walchia*, and *Trombicula*—and one new genus. *Hannemania* sp. was found on

two species of amphibians; *Walchia* sp. on two species of mammals; and *Trombicula* on three species of reptiles, four species of birds, and ten species of mammals. Species of *Trombicula*

TABLE 1.—*Distribution of chiggers, all species, on vertebrate hosts collected in the Duke Forest area, September 1947 to December 1949*

Hosts	Total No. hosts	No. hosts infested	Hosts	Total No. hosts	No. hosts infested
Amphibia			<i>Richmondia cardinalis</i> (Linnaeus)	3	1
<i>Plethodon glutinosus</i> (Green)	2	2	Mammalia		
<i>Bufo</i> sp.	2	1	<i>Didelphis virginiana</i> Kerr	10	3
Reptilia			<i>Blarina brevicauda</i> (Say)	11	5
<i>Terrapene carolina</i> (Linnaeus)	50	20	<i>Eptesicus f. fuscus</i> (Beauvois)	1	0
<i>Sceloporus undulatus</i> (Latreille)	9	4	<i>Lasinus b. borealis</i> (Müller)	7	0
Skink	1	0	<i>Nycticeius humeralis</i> (Rafinesque)	1	0
<i>Carpophis a. amoena</i> (Say)	4	0	<i>Procyon lotor</i> (Linnaeus)	7	1
<i>Thamnophis o. ordinatus</i> (Linnaeus)	2	0	<i>Mustela vison</i> Schreber	2	0
<i>Elaphe obsoleta</i> (Say)	1	0	<i>Urocyon cinereoargenteus</i> (Schreber)	1	0
<i>Agkistrodon mokasen</i> (Beauvois)	5	3	<i>Sciurus c. carolinensis</i> Gmelin	26	15
Aves			<i>Glaucomys v. rolans</i> (Linnaeus)	6	1
<i>Accipiter velox</i> (Wilson)	1	0	<i>Reithrodontomys humulis</i> (Audobon and Bachman)	4	0
<i>Philohela minor</i> (Gmelin)	1	0	<i>Peromyscus leucopus</i> (Rafinesque)	392	305
<i>Coccyzus americanus</i> (Linnaeus)	1	0	<i>Peromyscus n. nuttalli</i> (Harlan)	9	1
<i>Strix varia</i> (Barton)	1	0	<i>Sigmodon hispidus komareki</i> Gardner	6	1
<i>Centurus carolinus</i> (Linnaeus)	1	0	<i>Microtus p. pennsylvanicus</i> (Ord)	14	5
<i>Sphyrapicus varius</i> (Linnaeus)	2	0	<i>Pitymys p. pinetorum</i> (LeConte)	3	2
<i>Dryobates villosus</i> (Linnaeus)	1	1	<i>Ondatra zibethica</i> (Linnaeus)	11	4
<i>Nannus hiemalis</i> (Vieillot)	1	0	<i>Mus musculus</i> Linnaeus	3	0
<i>Thryothorus ludovicianus</i> (Latham)	2	1	<i>Sylvilagus floridanus</i> (Linnaeus)	18	12
<i>Turdus migratorius</i> Linnaeus	1	1	<i>Sylvilagus p. palustris</i> (Bachman)	1	1
<i>Vireo flavifrons</i> Vieillot	1	0			

included *T. alfreddugèsi*, *Trombicula* near *akamushi*, *T. splendens*, *T. whartoni*, *Trombicula* spp., and two new species (*T. carterae* Brennan and Wharton, 1950, and *T. farrelli* Brennan and Wharton, 1950). The new genus was found on two species of mammals.

Collections of unattached chiggers and postlarval stages of trombiculids during the 30 months from October 1947 to March 1950. in the Duke Forest area are listed in table 5. There were

146 samples, representing 24 ecological niches, collected and placed on Berlese funnels. Except where noted, all collections were from upland hardwoods communities. Most of the samples

TABLE 2.—*Distribution of Euschöngastia species on mammalian hosts in the Duke Forest area, September 1947 to December 1949*

Hosts	Total collections	Number of positive collections				
		<i>E. peromysci</i>	<i>E. rubra</i>	<i>E. blarinae</i>	<i>E. carolinensis</i>	<i>E. setosa</i>
<i>Blarina brevicauda</i>	11	0	0	5	0	0
<i>Sciurus c. carolinensis</i>	17	1	0	0	0	0
<i>Peromyscus leucopus</i>	91	71	31	0	1	10
<i>Peromyscus n. nuttalli</i>	8	1	0	0	0	0
<i>Pitymys p. pinetorum</i>	3	1	0	0	1	0
<i>Ondatra zibethica</i>	9	2	0	0	0	0
<i>Sylvilagus floridanus mallurus</i>	17	0	1	0	0	1

(A collection consisted of all host specimens of one species collected in one locality on one date)

were taken during the months from November to April. During the May–October period, five samples from surface soil of fields and thickets yielded two positive for *T. alfreddugèsi* adults; one leaf accumulation from a hollow log was positive for *E. peromysci*; and the one collection of a *Sylvilagus floridanus mallurus* nest from a thicket was positive for engorged *T. alfreddugèsi*.

TABLE 3.—*Combinations of various species of chiggers in 91 collections of Peromyscus leucopus in the Duke Forest area, September 1947 to December 1949*

<i>Euschöngastia peromysci</i>	<i>E. rubra</i>	<i>E. setosa</i>	<i>E. carolinensis</i>	<i>Trombicula farrelli</i>	<i>T. carterae</i>	New genus	Frequency
x	x						19
x	x	x					3
x						x	3
x		x					2
x	x			x			2
x		x			x		1
x		x		x			1
x	x				x		1
x	x	x			x		1
x	x	x		x			1
x	x				x	x	1
x	x				x	x	1
x			x				1

During this same period, two samples from surface litter and debris, two of surface soil, one of humus from logs, one from under loose bark of a standing dead hardwood stub, and one

deserted and two occupied *Peromyscus n. nuttalli* nests were negative.

In the collections from soil, 7 to 30 cm. depth, the soil samples were taken from the side of a trench dug in the forest floor. In several instances an area was sampled more than once. The 16 samples of surface soil from fields and thickets were taken from four areas. Surface debris was sampled three times near the base of a standing stub (pl. 2) with one positive sample. Two samples each from two sites resulted in four of the positive

TABLE 4.—*Distribution of chiggers other than Euschöngastia on hosts in the Duke Forest Area, September 1947 to December 1949*

Hosts	Species of chiggers									
	<i>Hannemania</i> sp.	<i>Walchia</i> sp.	<i>Trombicula</i> <i>alfreddugesi</i>	<i>T.</i> <i>splendens</i>	<i>T.</i> <i>wharioni</i>	<i>T.</i> near <i>akamushi</i>	<i>T.</i> <i>carterae</i>	<i>T.</i> <i>farrelli</i>	<i>Trombicula</i> sp.	New genus
<i>Bufo</i> sp.....	x									
<i>Plethodon glutinosus</i>	x									
<i>Terrapene carolina</i>			x							
<i>Sceloporus undulatus</i>			x							
<i>Agkistrodon mokasen</i>			x							
<i>Dryobates villosus</i>			x							
<i>Thryothorus ludovicianus</i>			x	x						
<i>Turdus migratorius</i>			x							
<i>Richmondia cardinalis</i>			x							
<i>Didelphis virginiana</i>			x						x	
<i>Blarina brevicauda</i>										x
<i>Procyon lotor</i>		x								
<i>Sciurus c. carolinensis</i>		x		x	x				x	
<i>Glaucmys v. volans</i>									x	
<i>Peromyscus leucopus</i>			x			x	x	x		x
<i>Sigmodon hispidus komareki</i>					x					
<i>Microtus p. pennsylvanicus</i>					x					
<i>Ondatra zibethica</i>					x					
<i>Sylvilagus floridanus mollurus</i>			x		x					
<i>Sylvilagus p. palustris</i>					x					

samples from surface soil in hardwoods. One of the sites was the type locality of *E. carolinensis* (pl. 2). Two sites (pl. 2, upper right and lower left) with three samples each gave six of the positive samples from under old stumps and from decayed-out root systems; another site in two samples gave one positive and the only negative for this niche. Fifteen samples from one stub (pl. 2) resulted in nine of the positive samples taken under loose bark of standing dead stubs and trees. Another stub gave one



Upland hardwood forest, Compartment 76, Durham Division, Duke Forest, N. C.,
habitat of species of *Euschöngastia* and their common hosts.

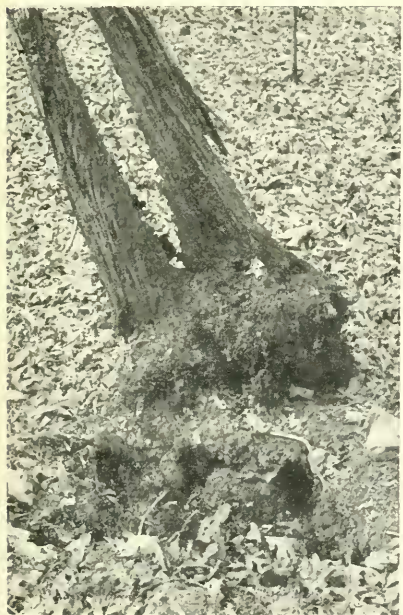
PLATE 2

Upper left: Type locality of *Euschöngastia carolinensis*, Compartment 77, Durham Division, Duke Forest, N. C. The chiggers were recovered from soil at the base of the shrub.

Upper right: Type locality of *Euschöngastia rubra*, Compartment 76, Durham Division, Duke Forest, N. C. The small, curved, decayed stump (at the left, upper edge of the large shadow) was removed. The chiggers were recovered from the debris under the stump.

Lower left: Cavities left by decomposition of a root system, Compartment 76, Durham Division, Duke Forest, N. C. For the photograph the stump was lifted from its position in the ground. A few *Trombicula farrelli*, *Euschöngastia rubra*, and *E. setosa* and many *E. peromysci* were recovered from the debris in the cavities.

Lower right: Standing dead stub, Compartment 8, New Hope Creek Division, Duke Forest, N. C. Identified from wood and bark samples as "one of the red oaks" by Dr. E. S. Harrar, Department of Forestry, Duke University. *Trombicula splendens* adults and *Trombicula* sp. adults, nymphs, and larvae were collected from the debris under the loose bark of the stub. One undetermined adult trombiculid was collected from the debris at the base. *Peromyscus leucopus* with *Euschöngastia peromysci* and *E. rubra* in its ears was trapped at the base of the stub. No unattached *Euschöngastia* was taken at this site.



EXPLANATION ON FACING PAGE

PLATE 5

Upper: Andropogon field, Compartment 16, New Hope Creek Division, Duke Forest, N. C. The field is small and partly surrounded by upland hardwoods. *Peromyscus leucopus*, infested with species of *Euschöngastia*, was trapped in the surrounding hardwoods but was never taken in the field. *Microtus*, *Sigmodon*, and *Reithrodontomys* were trapped in the field but never in the surrounding hardwoods. *Microtus* and *Sigmodon* were parasitized by *Trombicula whartoni* but never by *Euschöngastia*. *Trombicula whartoni* was never collected from *Peromyscus leucopus*.

Lower: Detached *Euschöngastia peromysci* on the ear of *Peromyscus leucopus*, the deer mouse, $\times 5.5$.



EXPLANATION ON FACING PAGE



Photomicrographs of scuta, $\times 975$. Upper: *Euschöngastia trigenuala*.
Middle: *E. diversa acuta*. Lower: *E. rubra*.



Photomicrographs of scuta, X 975. Upper: *Euschöngastia crateris*.
Middle: *E. carolinensis*. Lower: *E. blarinae*.



positive in six samples. The hollow base of one tree was sampled twice with one positive.

TABLE 5.—*Distribution of unattached chiggers and postlarval stages of trombiculids collected from ecological niches in the Duke Forest area, October 1947 to March 1950*

Niches sampled	Total samples	Total positive samples	Chiggers and post-larval trombiculids	Positive samples
Surface soil, fields and thickets	16	6	<i>T. alfreddugèsi</i> nymphs and adults.	6
Surface litter and debris	7	2	<i>E. peromysci</i>	1
			Trombiculid adult	1
Surface soil and humus	27	6	<i>E. blarinae</i>	1
			<i>E. peromysci</i>	1
			<i>E. rubra</i>	2
			<i>E. carolinensis</i>	2
			<i>T. whartoni</i>	1
Soil, 5 to 15 cm. depth	1	1	<i>E. peromysci</i>	1
Soil, 19 to 30 cm. depth	1	1	<i>E. rubra</i>	1
Soil and debris under logs	1	0		
Mammal runways and burrows	6	4	<i>E. blarinae</i>	1
			<i>E. peromysci</i>	3
			Trombiculid adult	1
			New genus	1
Hollow base of tree	5	3	<i>E. rubra</i>	1
			<i>Walchia</i> sp.	1
			Trombiculid nymph	1
Humus from logs and stumps	9	2	<i>E. peromysci</i>	2
Under old stumps and decayed-out root systems	13	12	<i>E. blarinae</i>	2
			<i>E. carolinensis</i>	2
			<i>E. peromysci</i>	10
			<i>E. rubra</i> (one engorged)	6
			<i>E. setosa</i>	1
			<i>T. farrelli</i>	1
			Trombiculid adults	3
Under bark of fallen trees	4	0		
Humus from decaying branch against stub	1	1	<i>Trombicula</i> sp.	1
Under loose bark of standing dead hardwood trees and stubs	35	12	<i>T. farrelli</i>	1
			<i>T. splendens</i> adults	3
			<i>Trombicula</i> sp.	6
			<i>Trombicula</i> sp. nymphs and adults	9
Under loose bark of pine stub	1	0		
Debris scraped from standing dead tree	1	0		
Debris from crotch of oak tree	2	0		
Cavity in living tree	3	1	<i>Trombicula</i> sp.	1
			<i>Walchia</i> sp.	1
Leaf accumulations in hollow logs	4	3	<i>E. peromysci</i>	2
			Trombiculid nymph	1
<i>Peromyscus n. nuttalli</i> nest, occupied	2	0		
<i>Peromyscus n. nuttalli</i> nest, deserted	3	1	Trombiculid adults	1
<i>Sciurus c. carolinensis</i> nest, occupied	1	1	<i>T. whartoni</i> (engorged)	1
<i>Sciurus c. carolinensis</i> nest, deserted	1	0		
<i>Sylvilagus floridanus mollurus</i> nest, about one day vacant, thicket	1	1	<i>T. alfreddugèsi</i> (engorged)	1
Ant nest in pine stump	1	0		

All five species of *Euschöngastia* that were collected from hosts in the Duke Forest area were recovered also in the unattached and unengorged condition from one or more of these samples. *E. peromysci* occurred in twenty samples; *E. rubra*, in ten; *E. blarinae*, in four; *E. carolinensis*, in four; and *E. setosa*, in one. The number of chiggers recovered from a positive sample usually was small—from one to three specimens. However, a few samples collected under decayed stumps produced a great many *E. peromysci*. Other species were never numerous. Most productive samples were taken under old stumps and in holes left by decayed roots (pl. 2), and in the runways of mammals. No collection of *Euschöngastia* was made from standing living or dead trees; none was made from fallen trees or branches unless decay was well advanced and a hollow formed; and none was made from fields (pl. 3, upper). All positive samples were from forest soil or from sources in intimate contact with it.

Three collections of white trombiculid adults, a total of seven specimens, were made from material gathered under the removable stump at the type locality of *E. rubra* (pl. 2, upper right). These probably were *Euschöngastia*, but confirmation of this could not be made.

Phylum ARTHROPODA

Subphylum CHELICERATA

Class ARACHNIDA

Order ACARINA

Suborder TROMBIDIFORMES

Group PROSTIGMATA

Family TROMBICULIDAE Ewing, 1944

Subfamily Trombiculinae Ewing, 1929

Genus *Euschöngastia* Ewing, 1938

FIGURE 8,b

Schöngastia Oudemans [part], 1910, pp. 86, 87 (fide Sig Thor and Willmann, 1947, p. 297).

Neoschöngastia Ewing [part], 1929d, pp. 22, 28, 188.

Euschöngastia Ewing, 1938, p. 293.

Euschöngastia, Vitzthum, 1942, p. 829 (treated as a subgenus of *Schöngastia* Oudemans, 1910).

Ascöschöngastia Ewing [part], 1946b, p. 71.

Boshellia Ewing, 1950, pp. 294-295, 296.

TYPE OF GENUS: *Euschöngastia americana* Ewing, 1938 (= *Euschöngastia sciuricola* (Ewing, 1925)). Monotypic.

MORPHOLOGY

All chiggers have the same basic external form. The size is small, rarely more than a millimeter in length even when heavily engorged and greatly flattened in preservation on slides. (In this paper the dimensions of length and width are given in microns.) Colors range through white, cream, yellow, and various intensities or shades of red. The body is oval or ovoid in shape, more or less inflated, in one unit without apparent segments. Attached to the anteroventral portion are two pairs of jointed appendages, the pedipalps and the chelicerae, which constitute the mouthparts or gnathosoma. From the base of each palp a flaplike process, the galea, curves forward and upward around the anterolateral surface of each chelicera. Immediately posterior to the gnathosoma on the lateral portions of the ventral surface are three pairs of jointed walking legs terminating in two lateral claws and a median empodium. On the anterodorsal surface, slightly posterior to the gnathosoma, is a sclerotized plate, the scutum. One or two pairs of simple eyes, usually, are located lateral to the scutum. The body surface is covered with cuticular striae which generally encircle the scutum and the basal segments of the legs. Posteriorly the striae tend to run at right angles to the longitudinal body axis. The anus is situated on the ventral surface considerably anterior to the apparent posterior end of the mite. The mouth is not obvious but is located at the bases of the chelicerae and the palps. The body is clothed with transverse rows of setae. These setae are usually more or less plumed by setules, tapered projections from the central shaft. The galeae, the segments of the palps, and the segments of the legs bear setae which are nude or plumed with setules. Nude striated setae may be found on the final segment of the palps and on the three distal segments of the walking legs. The scutum carries setae, usually with setules, which vary in number in various groups of chiggers. Two specialized setae, the sensillae, are always found on the scutum. The sensillae arise from pits, the pseudostigmata. In some groups of chiggers true stigmata are located near the base of the gnathosoma. Indented in the posterior edge of the first or proximal segment of the first pair of walking legs is a pit, the urstigmen. The scutum, segments of the palps, the basal segment of the chelicerae, and the segments

of the legs may be decorated with punctations, or punctae. Punctae are usually described as pits in the cuticle.

Within the basic chigger pattern the genus *Euschöngastia*, as it is now known in North America, has its own basic form (figs. 1-3). The size varies but all specimens have been less than a millimeter in length. Measurements are made from specimens preserved on slides. The length is the over-all measurement from the posterior edge of the body to the most anterior extension of the body or the gnathosoma. The width is the widest dimension. Shape, unless otherwise indicated, is taken from specimens preserved on slides. Color is recorded from living specimens.

The gnathosoma is compact and somewhat cone-shaped. The palps have five segments. The basal segments of the two palps, the coxae, are fused to form a single ventromedian plate. It is usually marked with punctae. Also fused with it are the trochanters, although the line of fusion often can be determined. At the anterolateral corners of the fused coxae, posterior to the union with the trochanters, is a pair of curved setae with setules along the outer curvature. The palpal coxa is often referred to as palp 1 in descriptions and drawings. The palpal femur, palp 2, swells forward and upward. It is rounded laterally on the dorsal aspect but usually is somewhat excavated on the posterolateral surface from the ventral aspect. It bears on its dorsal surface, posterolaterally, a single seta which curves anteriorly. The seta is covered with setules except that the concave curvature adjacent to the palp tends to be nude. The palpal genu, palp 3, is a short truncate cone smoothly continuing the taper of the femur. On its dorsal surface is a single forward-curving seta which usually bears setules on the convex curvature. In two species normally and in a third occasionally, the seta is nude. The palpal tibia, palp 4, continues the taper of the genu and terminates in the palpal claw. It bears three setae. The first tibial seta is a forward-curving dorsal which usually has setules on the outer curvature. The second is lateral. It varies in different species and is much used as a taxonomic character. It may have numerous setules on its outer curvature and be described as pectinate; it may bear only one or more setules, which can be counted easily, and be described as forked or branched; or it may be entirely nude. The third tibial seta is ventrolaterally placed. It usually projects laterally, and in all species except one has setules over the longitudinal dorsal half of the shaft. The palpal claw is divided into two to seven prongs in different species. When the

length of the palpal claw is given in descriptions, the total length, including the basal portion imbedded in the tibia, is used. The tarsus, palp 5, is a short, thumblike segment attached ventrally to the tibia at the base of the palpal claw and opposable to it. In most species the tibia bears seven feathered setae—a large dorsal, three near the apex, and three basal and ventral. Ventrally, near the articulation with the tibia, the tarsus bears a striated seta, or spur.

On each galea is a seta which in different species varies in form. It may be nude, forked, branched, or pectinate; or the setules may arise on opposite edges of the shaft. The galeal seta is an important taxonomic character.

A chelicera is composed of two segments. The base is heavy, usually angulate laterally, and may have punctae on its dorsal surface. The distal segment is bladelike and curved. It bears near the apex a dorsolateral tooth, which sometimes cannot be found, and a larger ventrolateral tooth.

The legs are composed of seven segments. By convention for brevity the three pairs of legs are numbered with Roman numerals from anterior to posterior—I, II, and III. The segments of the legs are numbered with Arabic numerals. However, the two sets of numerals are not used together except in designating drawings. The coxa, or basal segment articulating with the body, is segment 1. The first freely movable segment, the trochanter, is segment 2. The femur is divided into two parts. The more proximal part is the basifemur, segment 3; and the more distal part is the telofemur, segment 4. The genu is segment 5. The tibia is segment 6. The most distal, terminal segment is number 7, the tarsus. On the leg segments are various specialized striated setae and nonspecialized feathered setae. Some are constant throughout the genus, others vary. All segments have nonspecialized setae with setules. On all segments except the coxae and the trochanters these setae tend to lie parallel with the leg. Those on the coxae extend posteriorly. Those on the trochanters tend to curve ventrally and posteriorly around the segment. All are nude on the side adjacent to the leg or the body; the side opposite to the leg or body bears setules of slightly varying length and form in different species. The segments may be marked with punctae.

On the coxa of leg I is a nonspecialized seta attached near the anterior margin of the urstigmen. The trochanter bears a nonspecialized seta attached proximally at the anterodorsal margin, curving posteriorly beneath the segment. The basifemur has a

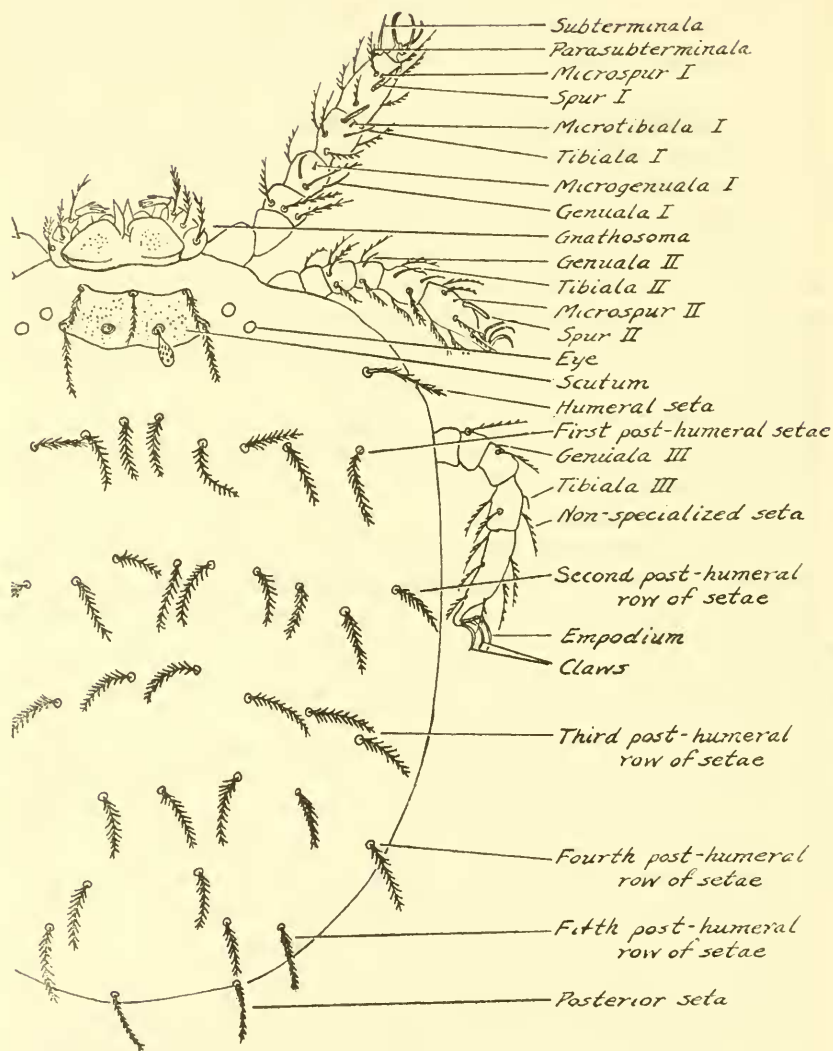


FIGURE 1.—Dorsal view of *Euscöngastia oregonensis*.

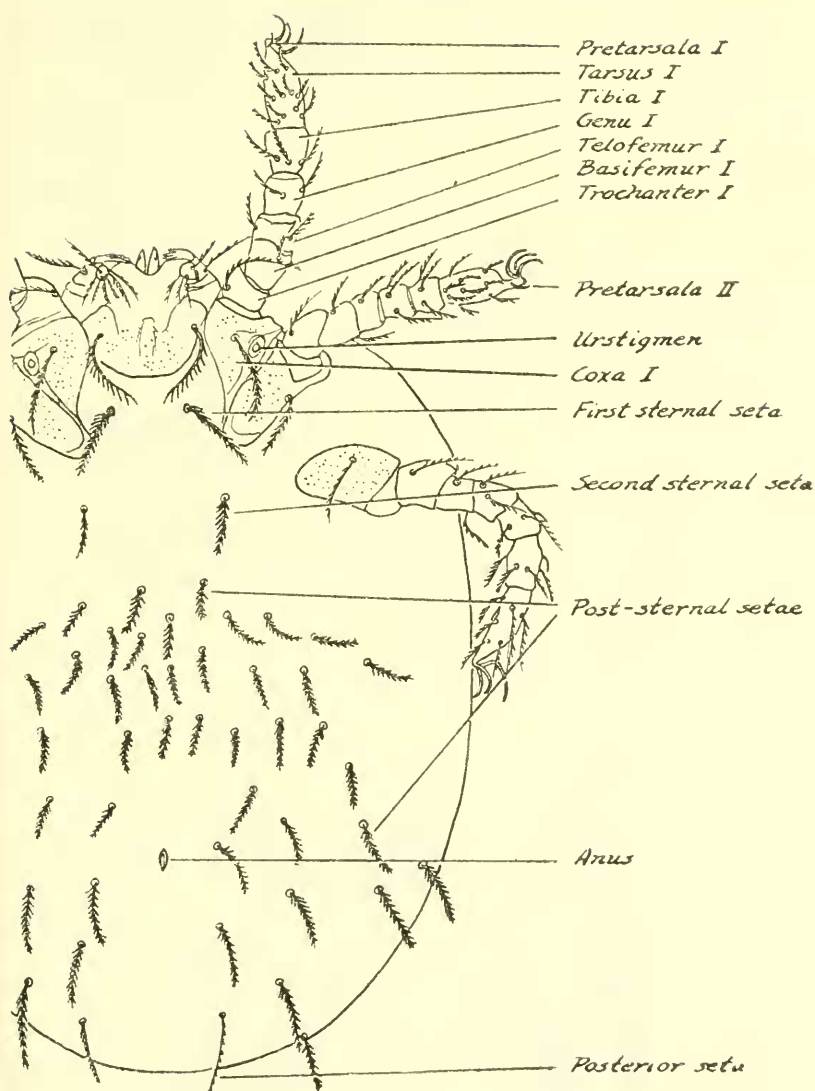


FIGURE 2.—Ventral view of *Euschöngastia oregonensis*.

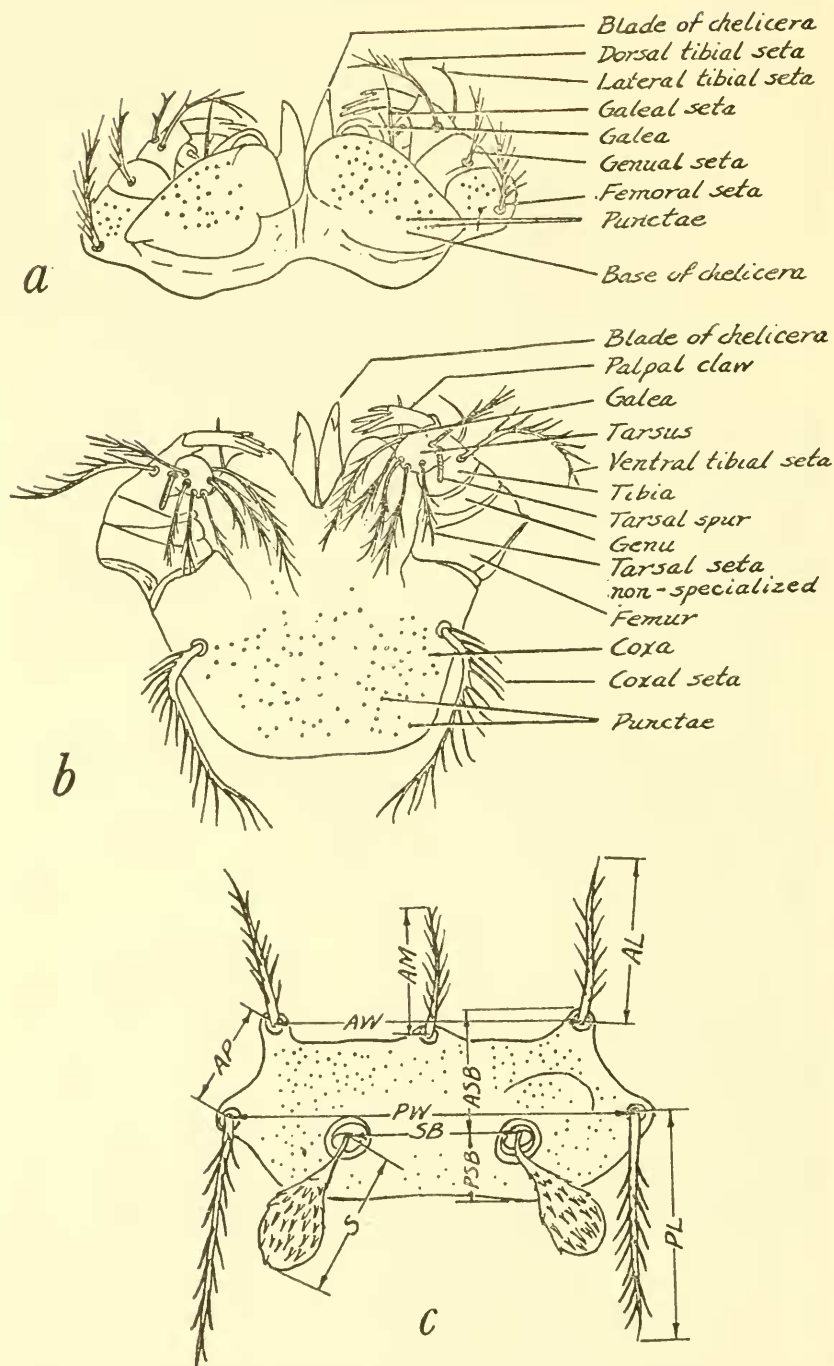


FIGURE 3.—*a*, Dorsal view of gnathosoma of *Euschöngastia oregonensis*; *b*, ventral view of same; *c*, scutum of *E. oregonensis*, with measurements of standard data (explanation of abbreviations on page 123).

single nonspecialized seta attached distally at the posteroventral margin. The telofemur bears five nonspecialized setae, three proximally in a transverse row across the dorsal surface and two on the ventral surface. The genu bears four nonspecialized setae about evenly spaced around it on the proximal half. Usually it has, also, two rather long, pointed, striated, specialized setae—the genualae. One of these is dorsal and anterior; the other is posterior. A small, pointed, striated microgenuala is located distally on the dorsal surface. The tibia usually has seven nonspecialized setae, one proximally on the dorsal surface, one at the middle of the anterior dorsal margin, one on the posterior dorsal margin, and four on the proximal half of the ventral surface. The tibia bears two striated, specialized tibialae. The tibiala on the distal, dorsal margin is somewhat blunt; the one proximal to it is pointed. Just posterior to the distal tibiala is a small, pointed, striated microtibiala. The tarsus bears about 22 nonspecialized setae. Near the middle of its dorsal surface is a strong, blunt, striated seta, the spur. Slightly distal, usually, to the spur is a small pointed striated seta, the microspur. Distally and anteriorly, on an eminence of the tarsus in all but two species, are two striated setae. The larger and more distal of the two is the subterminala; the smaller, slightly more proximal, is the parasubterminala. Beyond the eminence of the tibia, the segment tapers quickly to the rather slender pretarsus, at the end of which are two lateral, curved claws with a thinner curved empodium between them. On the posterior edge of the pretarsus just proximal to the claws is a pointed, striated seta, the pretarsala.

The coxa of leg II is contiguous with coxa I. It has a long, nonspecialized seta attached at its posterior margin. A long, nonspecialized seta is fastened proximally on the anterodorsal margin of the trochanter. The basifemur bears two nonspecialized setae, one anterior and one posterior. The telofemur has four nonspecialized setae, three proximally in a transverse row across the dorsal surface and one on the anterior surface. The genu has three nonspecialized setae spaced around the proximal half. On its middorsal surface, usually, is a pointed, striated seta, the genuala. The tibia bears six nonspecialized setae—one anterior and one posterior on the dorsal surface, two on the ventral surface, and one each on the anterior and posterior surfaces. Two striated setae, the tibialae, are located on the dorsal surface in tandem. The proximal tibiala is more pointed than the distal.

The tarsus bears about 16 nonspecialized setae. On its dorsal surface is a long, blunt, striated spur with a microspur just proximal to it. On the posterior edge of the pretarsus is the pointed, striated pretarsala. Two claws and an empodium similar to those on leg I are attached to the end of the pretarsus.

The coxa in leg III is separated from coxa II, the distance increasing with engorgement. A single seta, usually, is attached near its anterior margin. The form of coxa III and the attachment of its seta vary slightly in different species. The trochanter has a nonspecialized seta attached proximally at the anterodorsal margin. The basifemur has two nonspecialized setae—a larger dorsal and a smaller ventral. On the proximal dorsal surface of the telofemur is a transverse row of three nonspecialized setae. The genu has three nonspecialized setae spaced around it. Usually there is a pointed, striated genuala on its dorsal surface. The tibia has six nonspecialized setae spaced around it. In about half the species a pointed, striated tibiala is found on the proximal half of its dorsal surface. The tarsus bears about 15 nonspecialized setae. One species has a long, nude, whiplike seta, a mastitarsala. The tarsus terminates in a pair of claws and a median empodium somewhat longer than those on legs I and II.

The scutum varies in size and shape among the species of *Euschöngastia*. Ornamentation varies also, but ridges and punctae are usual. In some species the striated cuticle appears to have encroached upon or to have folded over the posterior or lateral margins. There are always five setae in addition to the sensillae. Near the middle of the anterior margin is the anterior median seta. At the corners between the anterior and lateral margins are the anterior lateral setae. At the angles between the lateral margins and the posterior margin are the posterior lateral setae. These setae are clothed with setules. The five scutal setae generally resemble the dorsal setae. All *Euschöngastia* have expanded sensillae. The sensillae arise from the pseudostigmata, which are rather large and deep pits in the scutum. The slender, basal pedicel may gradually become larger in diameter and blend into the head of the sensilla; or it may increase very little and be distinctly set off from the enlarged head. The enlarged head is clothed with setules. In many species the posterior surface of the sensilla bears fewer and heavier setules than the anterior surface. For the determination of anterior and posterior surfaces, the sensilla is considered to be standing erect on the scutum.

The standard data of the scutum (fig. 3,c), which are included in descriptions of species, consist of measurements in microns

of several dimensions of the scutum and the lengths of the setae. All measurements involving setae or sensillae start at the mid-point of the basal attachment. Often, the width of the sensilla is given and is indicated by an "x" following the length.

Following are the explanations of the abbreviations used in connection with these dimensions:

- AW: Width of the scutum between the bases of the anterior lateral setae.
- PW: Width between the bases of the posterior lateral setae.
- AP: Distance between the bases of an anterior lateral seta and a posterior lateral seta on one side.
- SB: Distance between the sensillary bases, the points of attachment of the sensillae.
- ASB: Distance from the anterior margin to the bases of the sensillae. When the anterior setae are set on anterior expansions of the scutum, these expansions are included in ASB. For the purpose of determining standard data, the anterior margin is considered to lie at a straight, transverse line touching the most anterior points of these expansions.
- PSB: Distance from the bases of the sensillae to the posterior margin, which is considered to lie at a straight, transverse line touching the most posterior expansions of the scutum.
- AL: Length of an anterior lateral seta.
- AM: Length of the anterior median seta.
- PL: Length of a posterior lateral seta.
- S: Length of a sensilla.

Two pairs of simple eyes usually are present. Two species have ocular plates. Two species have one pair of obscure eyes.

Dorsal body setae are arranged in transverse rows which are usually distinct, especially in partly engorged specimens. A pair of humeral setae, one seta on each side of the body, is set off anterolaterally in engorged specimens; but in unengorged specimens these setae may lie at the ends of the first transverse row. By convention in descriptions of chiggers the dorsal setal formula consists of listing serially the number of setae in each of the transverse rows, beginning with the humeral setae and proceeding posteriorly. Frequently there are setae on the lateral edges of the body not easily assignable to a row. These are inserted in the formula where they occur and are usually recognizable by being smaller numbers between larger numbers. In a list of several dorsal formulae these so-called lateral setae will not be indicated in all specimens. The dorsal setae usually resemble the scutal setae. The form of the posterior setae may differ from that of the anterior setae. Particularly in unengorged chiggers, the setae project posteriorly somewhat parallel to the body. They tend to be nude on the side adjacent to the body.

On the ventral surface of the body a pair of feathered setae is found between coxae I. These are the first or anterior sternal setae. The second or posterior sternal setae are located between coxae III. With one exception there is one pair of second sternals; in one species there are four second sternals. All sternals curve posteriorly and have relatively long and slender setules on the outer curvature. Posterior to coxae III the number of ventral setae varies with species and specimen. The arrangement into rows is indistinct in most species, and ordinarily no effort is made to count these setae by rows. A ventral setal formula consists of enumerating the first sternals and the second sternals plus the total number of setae posterior to the sternals. However, since the number of sternals is so constant in a species that deviations are considered anomalous, ventral formulae usually are not given in the descriptions. The number of sternals common to the species and the range of variation of the setae posterior to the sternals is given. All poststernal setae may be similar to the dorsals; or there may be a rather sharp change in form about the level of the anus. In the latter case the setae posterior to the anus have the form of the dorsals; and those anterior to the anus have a different form. Ventral setae lie somewhat parallel to the body and tend to be nude on the side adjacent to the body.

In the descriptions of the species and groups of species a general description will not be repeated. Attention will be concentrated on those features which at this time appear to be important in making combinations of species or in differentiating them. In plates 9-21, the appendages and their segments are referred to by numbers. The order of the appendages and their parts are the same as has been followed in this general description of the morphology of the genus. All measurements are in microns.

DIAGNOSIS

The diagnosis of *Euschöngastia* by Fuller (1952), after emendation, has been adopted for this paper: All legs with seven segments; true stigmata and tracheae absent; empodium clawlike; no caudal plate; eyes usually present; coxa II with a single seta; scutum with five setae in addition to sensillae; scutum not submerged beneath the cuticular striae; sensillae expanded distally; chelicerae bladelike, each with a single dorsal tooth; palpal claw with two to seven prongs.

A note should be added to this diagnosis. In the closely related genus *Neoschöngastia* the scutum is submerged beneath the cuticular striae. In a few species of *Euschöngastia* cuticular striae

appear to have folded over the posterior portion of the scutum, occasionally over the lateral margins.

Key to species of *Euschöngastia* of North America

1. Tibiala III present 2
No tibiala III 14
2. No subterminala or parasubterminala I ("*lacerta*" group) 3
Subterminala and parasubterminala I present 4
3. One genuala I; microspur I distal to spur 1. *E. lacerta* Brennan
Two genualae I; microspur I proximal to spur.
2. *E. bigenuala*, new species
4. Palpal claw with two prongs; a mastitarsala III present.
3. *E. nuñezi* (Hoffmann)
Palpal claw with more than two prongs; no mastitarsala III 5
5. Palpal claw with more than three prongs; sensillae elongate-clavate, joining with pedicels in gradual taper 6
Palpal claw with three prongs; sensillae capitate or subcapitate, heads more abruptly distinct from pedicels 9
6. Three genualae I 4. *E. trigenuala*, new species
Two genualae I 7
7. One pair of eyes, or corneas indistinct or lacking; galeal seta nude.
5. *E. pipistrelli* Brennan
Two pairs of eyes, corneas distinct; galeal seta branched 8
8. Lateral seta on palpal tibia branched 6. *E. oregonensis* (Ewing)
Lateral seta on palpal tibia nude 7. *E. samboni* (Radford)
9. Scutum with only two crescentic ridges, one anterior to each pseudostigma 10
Scutum with three joined ridges, one anterior to each pseudostigma and a third extending from the apexes of these anteriorly around the anterior median seta ("*rubra*" group) 11
10. Ventral setal formula begins 2-2 8. *E. peromysci* (Ewing)
Ventral setal formula begins 2-4 9. *E. cordiremus* Brennan
11. Lateral seta on palpal tibia pectinate; anterior and posterior dorsal setae similar 12
Lateral seta on palpal tibia usually nude; anterior dorsal setae with numerous long setules, posterior dorsal setae with fewer, scalelike setules (*E. diversa*, new species) 13
12. Scutum smaller, PW less than 67 microns; range southern.
10. *E. rubra*, new species
Scutum larger, PW about 77 microns; range northern.
11. *E. magna*, new species
13. Palpal claw shorter, branching on proximal half, accessory prongs interrupting contour of claw 12a. *E. diversa diversa*, new subspecies
Palpal claw longer, branching on distal half, accessory prongs lying close.
12b. *E. diversa acuta*, new subspecies
14. Palpal claw with three prongs 15
Palpal claw with more than three prongs 19
15. Two setae on coxa III 13. *E. guntheri* (Radford)
One seta on coxa III 16

16. Nonspecialized setae of leg I with numerous, fine, curved setules.
Scutum with strong ridges anterior to each pseudostigma, pseudo-
stigmata deeply recessed17
Nonspecialized setae of leg I with rather few, heavy, straight setules.
Scutum plain, or with ridges not strongly indicated, no deeply de-
pressed areas ("*luteodema*" group)18
17. Lateral seta on palpal tibia with one or two thin setules (or nude,
Brennan, 1948)14. *E. criceticola* Brennan
Lateral seta on palpal tibia strongly pectinate.15. *E. californica* (Ewing)
18. No genuala II or III16. *E. luteodema* Brennan
Genuala II and III present17. *E. marmotae*, new species
19. AL's and PL's long, about 70-80 microns, and about the same length;
scutum roughly rectangular18. *E. hamiltoni* Brennan
AL's much shorter than PL's; scutum tends to be pointed at postero-
lateral corners ("*blarinae*" group)20
20. Posterior dorsal setae leaflike, broad and thin with small setules on
surface away from body21
Posterior dorsal setae with round shaft with setules grouped around it 22
21. About final three rows of dorsal setae flattened; range southern.
20. *E. carolinensis*, new species
Flattened setae confined mostly to final dorsal row; range northern.
21. *E. ohicensis*, new species
22. Scutum and leg segments distal to coxae with punctae23
Scutum and leg segments distal to coxae without punctae24
23. Cheliceral base with punctae; galeal setae strong with setules along
opposite edges22. *E. crateris*, new species
Cheliceral base without punctae; galeal setae branched.
19. *E. blarinae* (Ewing)
24. Head of sensilla cordiform; cheliceral base without punctae; range
western24. *E. sciuricola* (Ewing)
Head of sensilla ovoid; cheliceral base with fine punctae; range eastern.
23. *E. setosa* (Ewing)

The "*lacerta*" group

The "*lacerta*" group consists of *E. lacerta* and *E. bigenuala*. The group is unique in the genus. The mites are very small. Body striae are fine. The anus is farther posterior than usual. Punctae on the cheliceral base are confined to the posterior portion. The number of body setae is reduced and the setae are small with fine setules. The nonspecialized setae of palps and legs are small with relatively few, fine setules. Tibia I has eight nonspecialized setae. The tarsi have fewer nonspecialized setae than usual, tarsus I having about 19 or 20, and tarsi II and III about 13 or 14. Subterminala and parasubterminala I are lacking. There are no genualae II and III. The general shape and character of the scuta of the two species in the group are similar. The pseudostigmata are set in the bases of short ridges which bound them antero-medially.

1. *Euschöngastia lacerta* Brennan

FIGURE 4,a; PLATES 6, 9

E. lacerta Brennan, 1948, pp. 465, 467-468, 477, figs. 2A-D, 9.

DESCRIPTION: With the characters of the group.

Size: Length, 330 to 350; width, 170 to 235.

Shape: Oval or ovoid.

Gnathosoma: Setae of palpal coxa, femur, and genu short, with few fine setules. Dorsal seta on palpal tibia fine with few setules; lateral seta fine with one or two fine setules; ventral seta with four or five fine setules. Palpal claw short, curved, stout, with three prongs, median longest and heaviest, but accessories stout. Tarsus small with four slender feathered setae and a tiny spur. Galeal seta fine with three to five fine setules. Cheliceral base slightly longer than broad; blade rather long and straight, curved at base and distal end; tiny dorsal tooth and larger ventral tooth distinct.

Legs: Leg I with a rather strong microgenuala on the distal dorsal surface and a single, fine genuala posterior to it. Tibia with two small tibialae set obliquely on the distal dorsal surface and a microtibiala posterior to the more distal of the two. Tarsus with a stout spur on its middorsal surface and a small microspur distal and slightly posterior to it; pretarsala small. Punctae few on segments 4, 5, and 6, not always apparent on coxa. Leg II with two short, blunt tibialae. Tarsus with a long, slender spur, a comparatively long microspur proximal to the spur, and a short pretarsala. Punctae few and large on coxa and segments 3, 4, and 5. Leg III with a slender, curving tibiala. Coxal seta on proximal half set well back from anterior margin; a few large punctae on coxa.

Scutum: About twice as wide as long. Anterior margin almost straight; lateral margins concave, curving posteriorly and laterally, posterior margin generally convex, slightly concave adjacent to the posterolaterals and medially. Setae slender with fine setules; anteromedian similar to anterolaterals and set well back from anterior margin; posterolaterals on slight elongations. Pseudostigmata near a line drawn connecting posterolaterals, varying from slightly anterior to slightly posterior, set apparently at an angle into the bases of short ridges arching over them anteromedially. Sensillae long, clavate, tapering from head to pedicel, widest about four-fifths the length from the base; covered with short, sharp setules which begin well down on the pedicel. Punctations lacking, but a small pit or pore present medial to each posterolateral seta.

Standard data of three paratypes from Santa Cruz County, Calif.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
47	68	21	24	22	13	18	25	29	-
49	75	25	26	23	13	23	28	32	34 x 11
46	64	22	17	19	14	22	-	38	36 x 10

Eyes: Two pairs in ocular plates; cornea not well defined on posteriors; diameter of anteriors about 9; of posteriors, 6.

Dorsal setae: Small, with short setules. Length of a humeral seta, 28; of a seta from the first row of posthumeral, 25; of a posterior seta, 19.

Dorsal formulae of two paratypes from Santa Cruz County, Calif.:

2 .. 6 .. 6 .. 6 .. 6 .. 2
2 .. 6 .. 6 .. 6 .. 8 .. 4

Ventral setae: Sternals and poststernals anterior to anus with longer, finer setules than dorsals. Setae posterior to anus similar to dorsals. Length of a first sternal, 24; of a second sternal, 24; poststernals all about the same length, 19.

Ventral formulae of two paratypes from Santa Cruz County, Calif.:

2 .. 2 plus about 26
2 .. 2 plus about 24

MATERIAL: One paratype borrowed from the Rocky Mountain Laboratory and two from the U. S. National Museum. Specimens from host:

Sceloporus o. occidentalis

Santa Cruz County, Calif., Aug. 15, 1945, 3.

DIAGNOSIS: *E. lacerta* differs from *E. bigenuala*, the other member of the "lacerta" group, by having a single genuala I, the microspur I distal to the spur, and the eyes in ocular plates.

REMARKS: *E. lacerta* is known from only one collection of four specimens, the type series. It is the only North American *Euschöngastia* reported from a cold-blooded vertebrate host.

2. *Euschöngastia bigenuala*, new species

FIGURE 4,a; PLATES 6, 9

DESCRIPTION: With the characters of the group.

Size: Length, 350; width, 235.

Shape: Oval.

Gnathosoma: Palps and chelicera similar to those of *E. lacerta*. Blade of chelicera more curved. Palpal claw with three prongs. Galeal seta with one setule.

Legs: Similar to *E. lacerta*. Genu I with two genualae, one dorsal and one posterior, and a rather long microgenuala. Microspur I proximal to spur. Spur I more distal than in *E. lacerta*. Tibialae shorter than in *E. lacerta*. All leg segments with conspicuous punctae.

Scutum: Generally similar to that of *E. lacerta*. Anterior margin concave with a slight convexity near the anterior median seta. Lateral margins more concave than in *E. lacerta* and the four corners more elongated. Pseudostigmata much closer together. Sensillae missing from specimen. Punctate. Cuticular striae appear to encroach on lateral margins.

Standard data of the holotype, from Galveston County, Tex.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
44	63	24	10	23	13	26	27	39	-

Eyes: Corneas of anterior eyes distinct; diameter, 9; posterior eyes indistinct. No ocular plate.

Dorsal setae: Similar to *E. lacerta*. Length of a humeral seta, 35; of a seta from the first posthumeral row, 36; of a posterior seta, 20.

Dorsal formula of the holotype: 2.6.6.6.6.4.

Ventral setae: More numerous than in *E. lacerta*. Length of a first sternal, 25; of a second sternal, 18; poststernals all about the same length, 18.

Ventral formula of the holotype: 2.2 plus about 40.

MATERIAL: Holotype only, USNM 1989. From host:

Sigmodon sp.

Galveston County, Tex., Aug. 8, 1947.

DIAGNOSIS: *E. bigenuala* differs from *E. lacerta*, the other member of the "*lacerta*" group, by lacking ocular plates, by having two genualae I, and by having its microspur I proximal to the spur.

REMARKS: Only one incomplete specimen of *E. bigenuala* has been collected. The very important sensillae are missing. However, the morphology of the group is so unusual and the correlation of *Euschöngastia bigenuala* with it is so complete that there can be little doubt of its position. *E. bigenuala* is named for the two genuala I which distinguish it from *E. lacerta*.

3. *Euschöngastia nuñezi* (Hoffmann)

PLATES 6, 10

Neoschöngastia nuñezi Hoffman, 1944, pp. 221-225, figs. 1-4.—Nuñez, 1947, pp. 221-237, 241-244, figs. 1-31.

Euschöngastia nuñezi, Fuller, 1952, p. 184.

DESCRIPTION: Size: Length, 490; width, 430.

Shape: Ovoid.

Gnathosoma: Seta on palpal coxa rather short with long setules. Seta on femur short with fine setules. Seta on genu nude. All three setae on tibia nude, fairly long. Palpal claw curved, cleft about half its length into two stout prongs, median prong stronger. Tarsus rather long; in addition to the usual setae a pointed seta about three-fourths as long as the spur is located on the medial ventral surface distal to the central of the three basal, feathered setae. Coxae punctate up to the galeae; femur punctate over its entire surface. Galeal seta long and nude. Cheliceral base strongly punctate. Cheliceral blade curved, with distinct teeth (Hoffmann, 1944); blade not present on specimen studied in U. S. National Museum.

Legs: Leg I with three genualae—two dorsal in tandem and one posterior—and a microgenuala. Tibia with two tibialae and a microtibiala and eight nonspecialized setae. Tarsus with strong tapered spur, a distal microspur, distinct subterminala and para-subterminala, and a pretarsala. Leg II with coxal seta set in from posterior margin, a genuala, two tibiala, a middorsal spur with proximal microspur, and a pretarsala. Leg III with a single genuala and single tibiala; tarsus with a single long mastitarsala on its dorsal surface near its base and 14 feathered setae. Setules of feathered setae of all legs straight. Coxae of all legs closely punctuate and all distal segments encircled with punctae.

Scutum: About three-fifths as long as broad; anterior margin sinuous; lateral margins slightly concave, diverge posteriorly; posterolateral corners slightly extended; posterior margin very slightly concave just medial to posterolaterals, deeply convex posterior to the pseudostigmata, and broadly concave between them; anterolateral setae not at the corners but set back on the lateral margins; anteromedian seta set well back from anterior margin; posterolaterals on the extended corners. All setae with short, scalelike setules. Pseudostigmata widely separated, slightly posterior to a line drawn between posterolaterals. Sensillae clavate, the pedicel expanding to a long, ovoid head widest about three-fourths its length from the base; head covered with very short, pointed setules. Surface without ridges; covered with punctae except for an almost clear zone near the anterior margin and around the anteromedian seta.

Standard data of the single paratype from México, D. F.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
62	79	19	36	30	18	36	41	63	38 x 13

Eyes: Two pairs in ocular plates lateral to the posterolateral setae; corneas distinct. Diameter of anterior eyes, 10; of posterior eyes, 9.

Dorsal setae: Similar in form to scutal setae; setules small. Length of a humeral, 50; of a seta from the first posthumeral row, 38; of a posterior seta, 36.

Dorsal formula of the single paratype: 2.6.6.4.4.2.

Ventral setae: Clearly of two forms; sternals and poststernals occupying the region just anterior to the anus similar to non-specialized leg setae, with rather long, straight setules on side opposite body; just anterior to the anus the form changes abruptly to that of the dorsal setae. Length of a first sternal, 44; of a second sternal, 42; of a seta from the first poststernal row, 37; of a posterior seta, 36.

Ventral formula of the single paratype: 2.2 plus about 19.

MATERIAL: A single paratype borrowed from the U. S. National Museum. From host:

Man

México, D. F., México, July 1944.

DIAGNOSIS: *E. nuñezi* is the only species of the genus now known in North America which has all nude setae on the palpal tibia, a pointed seta on the palpal tarsus in addition to the spur, and a mastitarsala III.

REMARKS: This species is known only from the original collections in México. It was found on man, parasitizing all members of one family, and on chickens in the same location. *E. nuñezi* is the only species of the genus in North America reported as a parasite on man.

4. *Euschöngastia trigenuala*, new species

FIGURE 4,a; PLATES 4, 6, 10

DESCRIPTION: Size: Length, 480 to 510; width, 345 to 370.

Shape: Oval to ovoid.

Gnathosoma: Seta on palpal femur rather small with few setules. Genu with a curving, nude seta. Dorsal seta on tibia with a row of setules along its outer curvature; lateral seta nude; ventral seta rather small with few setules. Palpal claw curved, usually with five prongs, median prong longest, two accessories slightly shorter, and two smaller on the outer curvature. Cheliceral base heavy; blade with distinct subapical dorsal and ventral teeth. Galeal seta nude. Palpal coxae and cheliceral base punctate.

Legs: Genu I with three genualae on its dorsal surface, two in tandem near the anterior margin and one near the posterior margin, and a microgenuala about midway on a line between the posterior genuala and the more distal of the two in tandem. Tibia with two typical tibiala and a microtibiala. Tarsus with typically arranged spur, subterminala, parasubterminala, and pretarsala, but with the microspur proximal and slightly posterior to spur. Leg II with one genuala, two tibialae, the microspur slightly proximal and posterior to the spur, and a pretarsala. Seta on coxa III set back from margin; no genuala III; tibiala III present. Nonspecialized setae with straight, rather fine setules. Punctae on all segments of all legs. Empodium on all legs more slender than claws but about same length.

Anomalies: Parasubterminalae lacking and the base of one subterminala enlarged on one specimen. Subterminala sinuate on one specimen.

Scutum: Anterior margin slightly convex. Anterolateral corners extended in round lobes on which the short anterolateral setae are attached. Lateral margins diverge posteriorly, rounding abruptly just posterior to posterolaterals. Posterior margin shallowly convex posterolateral to each pseudostigma and shallowly concave between the two. Anteromedian seta set back slightly from anterior margin. All setae with short setules. Pseudostigmata deep, anterior to a line drawn between posterolaterals. Sensillae long clavate, enlarging evenly from the slender pedicel; widest in the distal quarter; rounded distally; clothed with few widely and irregularly spaced, heavy setules; one or two setules terminal. A broad inverted U-shaped ridge anterior to each pseudostigma. Spots or mottling present but punctae not evident. One or two small pits or pores usually just medial to the posterolateral setae.

Standard data for five specimens from University of Oklahoma:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
61	80	24	32	22	16	23	31	39	35 x 9 (type)
58	75	25	28	22	18	22	32	38	37 x 9
61	85	26	30	22	19	25	32	38	35
65	86	27	32	22	17	23	32	32	38
57	76	25	28	24	16	25	35	38	33 x 9

Eyes: Usually not distinguished. One pair on one specimen slightly anterior to posteroiateral setae. Diameter, 12. Pigment granules usually present.

Dorsal setae: Anterior setae rather slender with numerous fine setules, similar to scutal setae; nude on side adjacent to body; setules of posterior group somewhat heavier. Length of humerals

of five specimens, 44 to 48; of setae in the first posthumeral row, 34 to 40; and of setae in the posterior group, 38 to 45.

Dorsal formulae for five specimens collected at University of Oklahoma:

2 .. 9 .. 11 .. 10 .. 10 .. 2 .. 8 .. 6 .. 2 (type)
 2 .. 10 .. 9 .. 9 .. 8 .. 7 .. 6 .. 2
 2 .. 11 .. 9 .. 9 .. 10 .. 8 .. 6 .. 1
 2 .. 10 .. 13 .. 11 .. 10 .. 8 .. 5 .. 2
 2 .. 10 .. 11 .. 11 .. 12 .. 10 .. 7 .. 2

Ventral setae: Sternals with fine setules. Setae between sternals and anus small with fine setules. At level of the anus, setae abruptly become large, and similar to dorsals. Data for five specimens: Number of first sternals, 2; of second sternals, 2; of post sternals, 39 to 48. Length of first sternals, all 44; of second sternals, 29 to 36; of setae in the first post sternal row, 23 to 27; of setae in the posterior group, 38 to 45.

MATERIEL: Type, USNM 1990. Specimens from host:

Scalopus sp.

University of Oklahoma, Sept. 13, 1933 (USNM, type + 2; DU, 4; RML, 2; CEF, 2; KU, 1).

DIAGNOSIS: *Euschöngastia trigenuala* is the only species with the following combination of characters: A nude seta on the palpal genu, feathered dorsal and ventral setae on the palpal tibia, and microspur I proximal to spur. The scutum and the sensillae also are distinctive.

REMARKS: The data given under "material" includes all that is known about the collection.

E. trigenuala is named for the three genualae on genu I.

5. *Euschöngastia pipistrelli* Brennan

FIGURE 4,c; PLATES 6, 11

Euschöngastia pipistrelli Brennan, 1947, pp. 249-251, figs. 3A-D.—Fuller, 1952, pp. 182, 184.

Euschöngastia miricoxa Brennan, 1948, pp. 465, 468-469, 477, figs. 3A-E, 10.

DESCRIPTION: Size: Length, 287 to 780; width, 185 to 520.

Shape: Ovoid.

Color: Opaque white.

Gnathosoma: Seta on palpal femur with few, spaced setules. Seta on genu variable, with one to four setules, or nude. Dorsal seta on tibia with two to four setules; lateral seta nude or with one or two tiny setules; ventral seta rather small with setules; palpal claw with five prongs, occasionally four prongs, median longest and strongest, two slightly shorter, and two more proxi-

mal on the outer curvature. Galeal seta nude. Setae appear strong but frequently are broken off. Basal segment of chelicera heavy; blade large, curved, subapical dorsal and ventral teeth distinct. Punctae on palpal coxa and on chelicerar base.

Legs: Leg I with two long, slender genualae and a microgenuala; two diagonally placed tibialae, the more distal one longer with typical microtibiala posterior to it; spur with microspur half length of spur or less distal, or distal and posterior; subterminala, parasubterminala, and pretarsala typically placed, long and strong. Leg II with one typical genuala, two tandem tibialae, a spur with proximal microspur, and a pretarsala. Leg III with single, slender genuala and tibiala. Leg segments robust, all with rather small punctae. Empodia more slender than the claws but about the same length. Feathered setae on the more proximal, free segments with rather long, curved setules; setules on feathered setae of tarsi generally straighter.

Scutum: Shape somewhat variable as lateral areas are extended more or less anteriorly. About twice as wide as long. Anterior margin generally concave with a convexity anterior to anterior median seta. Lateral margins concave, diverging posteriorly. Posterior margin extends more or less posteriorly, slightly concave behind the posterolaterals, convex posterior to the pseudostigmata, and usually slightly concave between them. The four corners somewhat extended. Setae long and heavy; anteromedian shortest, set close to anterior margin; posterolaterals exceptionally long; setules strong but rather widely spaced. Pseudostigmata well behind a line drawn between the posterolaterals. Sensillae broadly clavate; head well covered with long setules on the anterior surface, fewer on posterior surface; pedicels distinct. Surface covered with punctae; usually, a pair of larger pits medial to posterolaterals.

Standard data of the paratype from Stone County, Mo.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
60	80	25	22	35	11	70	45	109	32 x 16

Summary of standard data from 14 specimens from over the range, including the paratype (AL's from 12 specimens, AM's from 11, PL's from 13, S's from 6):

AW 60-80, mean 67.6; PW 76-103, mean 85.4; AP 16-25, mean 20.4; SB 22-37, mean 30.3; ASB 29-40, mean 34.4; PSB 8-13, mean 10.8; AL 44-70, mean 55.2; AM 36-50, mean 44.9; PL 104-126, mean 114; S 32-44, mean 39.2; width of sensilla 11-16, mean 13.7

Eyes: Usually not distinguished; one pair posterolateral to the posterolateral setae. Diameter about 6.

Dorsal setae: Long, curved; nude adjacent to body; long frag-

ile setules confined mostly to two alternate rows on the edge opposite the body. Rows irregular. Measurements from nine specimens: Length of humerals, 71 to 83; of setae near the middle of first posthumeral row .64 to 83; of posterior setae, 50 to 58.

Dorsal formulae of nine specimens:

Missouri	
Stone County:	2 .. 13 .. 9 .. 4 .. 11 .. 11 .. 8 .. 5 (paratype)
Illinois	
Jersey County:	2 .. 10 .. 9 .. 2 .. 8 .. 6 .. 2 .. 2
Ohio	
Clermont County:	2 .. 11 .. 12 11 .. 7 .. 5
Kentucky	
Carter County:	2 .. 10 .. 11 11 .. 8 .. 6
	2 .. 11 .. 10 11 .. 10 .. 6 .. 4
Pennsylvania	
Fayette County:	2 .. 13 .. 9 16 .. 11 .. 6 .. 2
Warren County:	2 .. 12 .. 12 10 .. 7 .. 2
McKean County:	2 .. 12 .. 11 12 .. 8 .. 5 .. 4
New York	
Broome County:	2 .. 10 .. 11 .. 1 .. 11 .. 9 .. 5

Ventral setae: Form like that of the dorsals. Data from nine specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 36 to 54. Length of first sternals, 48 to 58; of second sternals, 37 to 47; of setae near the middle of the first post-sternal row, 26 to 37; of posterior setae, 44 to 54.

Anomalies: One specimen with three second sternals. One specimen with one second sternal and two setae on one coxa III.

MATERIAL: Paratype borrowed from Rocky Mountain Laboratory. All other specimens in Duke University collection. Specimens from hosts:

<i>Myotis l. lucifugus</i>	<i>Pipistrellus subflavus obscurus</i>
New York	Pennsylvania
Schoharie County: 1884, 7.	Warren County: Sept. 12, 1947, 1.
<i>Pipistrellus s. subflavus</i>	<i>Myotis keenii septentrionalis</i>
Missouri	Pennsylvania
Stone County: Sept. 11, 1946, 1 (paratype).	Warren County: Sept. 20, 1947, 2.
Ohio	McKean County: Aug. 6, 1948, 2.
Clermont County: Oct. 16, 1949, 25.	<i>Pipistrellus subflavus</i>
<i>Myotis lucifugus</i>	Pennsylvania
Pennsylvania	Westmoreland County: Jan. 3, 1948, 1.
Westmoreland County: Oct. 19, 1946, 4.	<i>Myotis keenii</i>
Fayette County: Mar. 30, 1947, 1.	Pennsylvania
<i>Myotis sodalis</i>	Fayette County: Feb. 24, 1948, 1.
New York	<i>Myotis</i> sp.
Broome County: Aug. 11, 1947, 2.	Illinois
	Jersey County: Mar. 4, 1948, 1.
	Kentucky
	Carter County: Aug. 20, 1948, 4.

SEASONAL DISTRIBUTION: This species has been collected through the three winter months of January, February, and March and through the late summer and early fall months of August, September, and October. Whether this seasonal pattern indicates population peaks or merely lack of collections during the other months is not known.

GEOGRAPHIC DISTRIBUTION: The range of *E. pipistrelli*, as it is known from collections, extends from southwestern Missouri, into Illinois, Kentucky, and Ohio, through southwestern and northwestern Pennsylvania, to southeastern New York (fig. 4,c).

DIAGNOSIS: *E. pipistrelli* is the only species with the following combination of characters: Five (or four) prongs on palpal claw, tibiala III present, two genualae I, one pair of indistinct eyes, and nude galeal seta. The very long, heavy, posterolateral setae and the long dorsal setae, sparsely clothed with long setules, are different from those of any other species.

ECOLOGY: A very limited amount of ecological information is available on *E. pipistrelli*. It has been collected only from bats which typically inhabit caves. Most of the specimens used in this study were removed from bats which were captured in caves.

Collectors report the chiggers attached to the inner surface of the ear, on the rim of the ear near the base, on the tragus, near the eyes, on the chin, and at the corners of the mouth.

REMARKS: *E. pipistrelli* varies in certain characters throughout its range.

The occurrence of nude and branched setae on the palpal genu is unusual. The list of dorsal setal formulae indicates some of the variation in this character. The shape of the scutum varies, usually by the projection anteriorly of the lateral margins and a narrowing of the distance between the anterolateral and the posterolateral setae.

E. miricoxa Brennan, 1948, was described from a single specimen, the holotype, removed from a bat, *Myotis l. lucifugus* (LeConte), on Aug. 5, 1947, in Tompkins County, N. Y. This specimen was not examined in this study. However, from a comparison of the published description, drawings, and photograph of the scutum with a paratype of *E. pipistrelli* and other specimens of the species collected in the East, it appears that the range of variation of *E. pipistrelli* would include *E. miricoxa*. The extension of coxa I described for *E. miricoxa* probably is an apodeme beneath the integument. It can be found in specimens of *E. pipistrelli* and in other species. The shape of the scutum is approximated by scuta of certain specimens of *E. pipistrelli*. The form and arrangement of the setae is similar in both, so far as can be deter-

mined by comparing specimens with drawings. A set of drawings of the legs of *E. miricoxa* was obtained from the Rocky Mountain Laboratory. The form of the segments and the form and arrangement of the striated setae are typical of *E. pipistrelli*. The locality from which *E. miricoxa* was taken falls within the range of *E. pipistrelli* (fig. 4,c). A consideration of the standard data of the type series, of specimens from east of the Mississippi River, and of *E. miricoxa* does indicate that there is generally a smaller AP measurement for the eastern specimens. The average of 10 AP measurements from the type series, which is western, is 24 (Brennan, 1947). The AP measurement of *E. miricoxa* is 17 (Brennan, 1948). The AP measurements of 13 eastern specimens include these extremes, but the mean is 20. There is some possibility of subspeciation, but further collections and study are required for proper evaluation. The two species are here considered to be the same and *E. miricoxa* to be a synonym of *E. pipistrelli*.

6. *Euschöngastia oregonensis* (Ewing)

FIGURES 1, 2, 3, 4,a; PLATES 6, 11

Trombicula oregonensis Ewing, 1929a, p. 11; 1931, p. 9; 1942, p. 488.—Radford, 1942, p. 57.—Michener, 1946, p. 432.—Sig Thor and Willmann, 1947, pp. 260, 286.

Euschöngastia oregonensis, Fuller, 1948, p. 106; 1952, pp. 182-183, 184.

DESCRIPTION: Size: Engorged length, 505 to 535; width, 385 to 410.

Shape: Broad oval.

Gnathosoma: Rather small feathered seta on palpal femur. Seta on genu smaller, with few setules. Dorsal seta on palpal tibia longer with a few setules on its outer curvature; lateral seta with one to three setules; ventral seta with relatively few setules. Palpal claw curved with five prongs, median longest, two slightly shorter, and two shortest on the outer curvature. Galeal seta with one to three setules. Chelicera typical; subapical dorsal and ventral teeth distinct. Palpal coxa and femur and base of chelicera punctate.

Legs: Leg I with two typical genualae of moderate length and one microgenuala; two tibialae normally placed, the more proximal tibiala longer, and a microtibiala slightly posterior to the distal tibiala; strong spur on the middorsal surface of the tarsus with microspur about half the length of the spur distal and slightly posterior; subterminala, parasubterminala, and pretarsala typical. Leg II with one typical genuala, two tibialae in tandem, a strong spur with proximal microspur, and a pretarsala. Leg III with single, typical genuala and tibiala. Setules mostly

broken off the nonspecialized setae. Leg segments stout, rounded in legs I and II; all segments with punctae. Empodium about the same length as the claws.

Scutum: About twice as wide as long, slightly pointed at the posterolateral corners. Anterior margin straight with anterolateral corners extended and a small convexity anterior to the anteromedian seta. Lateral margins concave, diverging posteriorly. Posterior margin convex posterior to each pseudostigma and shallowly concave medially. Anterolateral and posterolateral setae set on extended corners. Anteromedian seta close to anterior margin. Posterolaterals longest; anteromedian shortest. Fine setules on all setae. Pseudostigmata rather widely separated, posterior to a line drawn between the posterolaterals. Sensillae broadly clavate, widest about three-fourths the length from the base; pedicel rather long and distinct; expanded portion covered with setules, fewer on posterior surface. Crescentic ridges indicated anterior to pseudostigmata. Surface punctate; in these specimens wide margins surround the punctae.

Standard data for the five specimens of the type series from Benton County, Oreg.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
65	86	23	33	28	12	34	30	46	
70	92	23	38	30	14	40	30	56	35x14 (lectotype)
63	93	26	38	27	14	38	32	52	
73	99	25	41	31	13	37	31	47	34
69	95	25	38	27	13	38	32	50	

Eyes: Two pairs, distinct but rather small; anterior and posterior eyes about the same diameter, 7.

Dorsal setae: Setae with rather fine setules of moderate length except the posterior group. Posteriors with fewer, shorter setules; end bluntly or with V-clefts. Measurements from five specimens: Length of humerals, 48 to 52; of setae near the middle of the first posthumeral row, 43 or 44; of setae in the posterior group, 43 to 45.

Dorsal formulae for five specimens of the type series from Benton County, Oreg.:

2	..	10	..	11	..	..	9	..	..	8	..	6	..	2		
2	..	11	..	?	..	..	?	..	..	?	..	?	..	?	(lectotype)	
2	..	12	..	13	..	2	..	9	..	2	..	8	..	6	..	2
2	..	10	..	10	..	2	..	8	..	2	..	8	..	2	..	2
2	..	11	..	10	..	2	..	9	..	..	8	..	6	..	2	

Ventral setae: General character similar to that of the dorsals. Data from five specimens: Number of first sternals, 2; of second

sternals, 2; of poststernals, 47 to 50. Length of first sternals, 47 to 59; of second sternals, 35 to 36; of setae near the middle of the first poststernal row, 25 to 26; of setae in the posterior group, 41 to 44.

MATERIAL: All cotypes in USNM (type No. 990). Specimens from host:

Mole

Benton County, Oreg., May 17, 1912, 5 (cotypes).

DIAGNOSIS: *E. oregonensis* can be distinguished by the following combination of characters: Tibiala III, subterminala and para-subterminala I, and two genualae I present; five prongs on palpal claw; two pairs of eyes; galeal seta branched; lateral seta on palpal tibia branched. It is very close to *E. samboni*, as the species are now defined, but it can be distinguished by the smaller setae on its gnathosoma and the branched lateral seta on its palpal tibia.

REMARKS: The original description of *E. oregonensis* is a description of a chigger typical of the genus *Trombicula*. The type host is given as a mole and the type locality as Corvallis, Oreg. The type slide is given as No. 990, U. S. National Museum. However, the specimens from the type slide, type host, and type locality, as indicated, are *Euschöngastia*. Fuller (1948), after examining the type specimens, placed the species in the genus *Euschöngastia*. The original description is not adequate for identification of the chiggers from the slide, but it does validate the name. The type specimen or specimens are the name bearers for the species. Therefore, Fuller's combination is here considered to be correct and the name of the species to be *Euschöngastia oregonensis* (Ewing, 1929).

The specimen of the cotypal series found on the slide marked "C. E. F. X." is here designated lectotype.

7. *Euschöngastia samboni* (Radford)

FIGURE 4,a; PLATES 8, 20

Neuschöngastia samboni Radford, 1942, pp. 76-77, fig. 99; 1947a, pp. 579, 599-600, figs. 27, 28; 1947b, p. 275.

Euschöngastia samboni, Brennan, 1948, p. 476.—Fuller, 1952, pp. 182, 184.

DESCRIPTION: Size: Length, 300 to 570; width, 200 to 510.

Shape: Ovoid to very broad oval.

Gnathosoma: Seta on palpal femur strong, with moderate number of setules. Seta on palpal genu smaller with relatively

few setules. Dorsal seta on palpal tibia strong and arching with few setules on its outer curvature; lateral seta on tibia nude; ventral seta with relatively few setules. Palpal claw strong, curved, usually with five prongs, occasionally four. Galeal seta strong, usually with one or two long, strong setules; occasionally nude. Cheliceral base heavy, blade strong and curved; dorsal subapical tooth small but distinct, ventral tooth larger. Rather small punctae on cheliceral base, palpal coxa, and palpal femur.

Legs: Leg I with two typical genualae and microgenuala, two typical tibialae and a microtibiala, a middorsal spur, a distal microspur, a subterminala, a parasubterminala, and a pretarsala. Leg II with one genuala and two tibialae, a tarsal spur, a proximal microspur, and a pretarsala. Leg III with a genuala and a tibiala, relatively short. Most nonspecialized setae on the free segments of leg I with numerous, rather short, fine, curved setules; on leg II the dorsal nonspecialized setae tend to have fewer, straighter setules; both types on leg III. Leg segments strong; legs without marked taper. All segments with punctae.

Scutum: Similar in general outlines and proportions to that of *E. oregonensis*. Anterior margin straight or slightly concave between the extended anterolateral corners and the small convexity just anterior to the anteromedian seta. Lateral margins concave, diverging posteriorly. Posterolateral corners extended. Posterior margin convex posterior to the pseudostigmata and slightly concave between them. Setae well clothed with moderate setules; anterolaterals and anteromedian setae about the same length, about half the length of the long posterolaterals. Pseudostigmata moderately separated; posterior to a line drawn between the posterolaterals. Sensillae clavate, widest about two-thirds the length from the base; heads tend to be slightly pointed, covered with rather long, smooth setules on the anterior surface and shorter, more offstanding setules on the posterior surface; pedicels distinct. Distinct inverted U-shaped ridge anterior to each pseudostigma, lateral leg extending to posterior margin. Surface with punctae, more numerous within the area inclosed by the crescentic ridges. One or two larger pits near the posterolateral terminus of each ridge.

Standard data for the three specimens studied from Ravalli County, Mont.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
71	96	27	33	35	13	44	44	90	38 x 16 (paratype)
63	90	29	27	32	14	43	43	64	38
65	87	25	34	30	12	45	41	71	-

Eyes: Two pairs lateral to the posterolaterals; no ocular plate. Diameter of anterior eyes, 10 to 12, mean 10.3; of posteriors, 8 to 10, mean 8.3.

Dorsal setae: Posterior group different in form from the anterior setae; anteriors well clothed with setules on the side opposite the body; posterior group with fewer, shorter setules exposing the shaft. Measurements from three specimens: Length of humerals, 61 to 72; of setae near the middle of the first post-humeral row, 50 to 57; of setae in the posterior group, 37 to 47.

Dorsal formulae of three specimens from Ravalli County, Mont.:

2 .. 12 .. 11 ..	2 .. 11 ..	7 ..	2 ..	2 (paratype)
2 .. 13 .. 14 ..	.. 12 .. 11 ..	8 ..	2	
2 .. 11 .. 15 ..	.. 12 ..	8 ..	5 ..	4

Ventral setae: Generally similar to dorsals. Data from three specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 52 to 60. Length of first sternals, 50 to 57; of second sternals, 40 to 44; of setae near the middle of the first poststernal row, 30 to 44; of setae in the posterior group, 33 to 47.

Anomaly: One specimen with three second sternals.

MATERIAL: Paratype in the U. S. National Museum; other specimens from the Rocky Mountain Laboratory now deposited in the Duke University collection. Specimens from hosts, all from Montana:

Pika
Ravalli County: Dec. 2, 1933, 1
(paratype).

<i>Ochotona p. princeps</i>
Ravalli County: Dec. 2, 1933, 1.
<i>Clethrionomys</i> sp.
Ravalli County: Oct. 12, 1945, 1.

SEASONAL DISTRIBUTION: *E. samboni* has been collected in fall and winter, October and December.

GEOGRAPHIC DISTRIBUTION: *E. samboni* has been collected only in Ravalli County, Mont. (fig. 4,a).

DIAGNOSIS: *E. samboni* can be distinguished by the following combination of characters: Tibiala III, subterminala and para-subterminala I, and genualae I present; five prongs, usually, on the palpal claw; two pairs of eyes; galeal seta usually branched; lateral seta on palpal tibia nude. *E. samboni* is very close to *E. oregonensis*, as the species are now defined. In the specimens studied, all the setae of the gnathosoma of *E. samboni* are larger; the galeal seta is heavier and the setules longer; and the lateral seta on the palpal tibia is nude.

REMARKS: The close morphological similarity between *E. samboni* and *E. oregonensis* has been indicated in the descriptions of both species. The localities from which the two have been collected are widely separated in miles but are in the same general geographic area (fig. 4,a). Collections of both species are scant. Further collections are necessary to determine the relationship between the two forms.

8. *Euschöngastia peromysci* (Ewing)

FIGURES 4,a, 5,a,b, 6,c,g,h; PLATES 6, 12

Schöngastia peromysci Ewing, 1929c, pp. 296-297.

Neoschöngastia peromysci, Ewing, 1931, p. 5.—Radford, 1942, p. 72.—Sig Thor and Willmann, 1947, pp. 311, 313.

Neoschöngastia signator Ewing, 1931, pp. 14-15, 19, pl. 2, fig. 1.—Radford, 1942, pp. 72, 74, 75, fig. 80.—Sig Thor and Willmann, 1947, pp. 311, 313, fig. 374.

Neoschöngastia brevipes Ewing, 1931, pp. 16, 19, pl. 2, fig. 4.—Radford, 1942, pp. 72, 74, 75, fig. 81.—Sig Thor and Willmann, 1947, pp. 311, 313, fig. 376.

Trombicula peromysci, Michener, 1946, p. 432.

Euschöngastia peromysci, Fuller, 1948, p. 108; 1952, p. 184.—Brennan, 1948, p. 470.

Euschöngastia signator, Fuller, 1948, p. 108; 1952, p. 184.

Euschöngastia brevipes, Fuller, 1948, p. 108; 1952, p. 183.

DESCRIPTION: Size: Length, 225 to 750; width, 115 to 565.

Shape: In life unattached, unengorged chiggers slightly flattened oval, widest at the third pair of legs; engorged, oval. Preserved on slides, oval to ovoid.

Color: Unengorged chiggers, cream or light yellow; engorged, opaque white. Red eyes.

Gnathosoma: Seta on palpal femur strong, curved, well clothed with setules except on the concave margin. Seta on genu curved, with two or three rows of strong, alternately arranged setules on the convex curvature. Dorsal seta on tibia curved, with two alternate rows of setules; lateral seta with a few setules which tend to arise near the base; ventral seta with about five alternate rows of strong setules over the dorsal surface of the shaft. Setules on all setae appear strong and stiff. Palpal claw slightly curved, three-pronged, the middle prong longer and heavier, the two accessories arising near middle of the claw and lying close against the median prong; length somewhat variable through the range of the species (fig. 5,b). Galeal seta of distinctive appearance, curving, bristlelike, usually with one to three stiff setules arising on the outer margin near the base; number of setules variable within about the same limits throughout the range with a ten-

dency to fewer setules from south and west to north and east (table 6). Chelicera with typical heavy base, curved blade, and distinct subapical dorsal and ventral teeth. Cheliceral base and palpal coxa and femur punctate.

Legs: Striated setae in typical arrangement. Leg I with two genualae and a microgenuala, two tibialae and a microtibiala, a spur and a distal microspur, a subterminala, a parasubterminala, and a pretarsala. Leg II with a genuala, two tibialae, a spur, a proximal microspur, and a pretarsala. Leg III with a genuala and a tibiala. All specialized setae strong and clear. Nonspecialized setae on free segments beyond the trochanters rather short but strong, with long, curved setules in regular alternate pattern. All leg segments with punctae.

Anomalies: One specimen with two setae on one coxa III. One specimen with three genualae on one genu I. One specimen with three tibialae I on one leg. One specimen with only one tibiala II on one leg. One specimen with a parasubterminala I equal in size to the subterminala. One specimen with the tibiala III missing from one leg.

Scutum: About a third to a fourth wider than long. Anterior margin broad W-shaped with the anterolateral setae and the anteromedian seta on the anterior extensions. Lateral margins concave, short, diverge slightly posteriorly. Posterolateral corners, very slightly extended, bear the posterolateral setae. Posterior margin usually rather deeply rounded posterior to each pseudostigma and shallowly concave between the two. Margins sometimes so pared that scutum appears skimpy. Setae densely covered with setules. Pseudostigmata well behind a line drawn between the posterolateral setae. Sensillae abruptly expanded, capitate; pedicels nude; heads covered with rather short setules. Anterior to each pseudostigma an inverted U-shaped ridge, the medial and lateral legs terminating about on a line with the posterior edges of the pseudostigmata; the two ridges sometimes continuous medially. Surface punctate. Sometimes with cuticular striae over the posterior margin. Apparently a tendency for scuta to become larger from south and west to north and east in the specimens from the area studied (fig. 5,a).

Summary of standard data from 100 specimens of *E. peromysci* from over its range (AL's from 99 specimens, AM's from 92, and S's from 59) :

AW 41-60, mean 50.2; PW 48-71, mean 56.6; AP 10-17, mean 13.5;
SB 17-32, mean 22.5; ASB 21-32, mean 27.3; PSB 6-12, mean 8.5;
AL 27-42, mean 34.9; AM 21-38, mean 26.8; PL 37-57, mean 46.4;
S 25-30, mean 27.1.

TABLE 6.—Distribution of setules on 580 galeal setae of *Euschöngastia peromysci* from 25 counties in Oklahoma, Ohio, Kentucky, North Carolina, Maryland, Pennsylvania, and Massachusetts

No. of setules per galeal seta	Frequency																								
	Latimer, Okla. Cotype <i>E. signator</i>	McKean, Pa.	Prince Georges, Md. Cotypes <i>E. brevipes</i>	Clermont, Ohio	Rowan, Ky.	Durham, N. C.	Orange, N. C.	Lancaster, Pa.	Montroe, Pa.	Wayne, Pa.	York, Pa.	Cameron, Pa.	Venango, Pa.	Clearfield, Pa.	Sullivan, Pa.	Bradford, Pa.	Worcester, Mass. Type <i>E. peromysci</i>	Lycoming, Pa.	Jefferson, Pa.	Westmoreland, Pa.	Union, Pa.	Bedford, Pa.	Schuylkill, Pa.	Center, Pa.	Pike, Pa.
0.....													1	1				5	2						
1.....						5	11		1			2	21	1	1	1		44	15	6	7	2	3	2	2
2.....					2	15	27	2		2	2		3	10	7	7	1	53	12	7	4	4	2	2	1
3.....		1	2		3	8	34	2		2	1	2	46	4	2	1		29	12	2	3		1		
4.....	1	1	1			7	8					1	1	1				6	1						
5.....	1					2	1						2												
Total....	2	2	3	1	6	37	81	4	4	4	3	8	101	17	10	9	1	137	42	15	14	6	6	4	3
Mean....	4.5	3.5	3.3	3.0	2.8	2.6	2.5	2.5	2.5	2.5	2.3	2.3	2.3	2.2	2.1	2.0	2.0	1.9	1.9	1.7	1.7	1.7	1.7	1.5	1.3

Anomalies: One specimen with two anteromedian setae. One specimen wider between the anterolaterals than between the posterolaterals.

Eyes: Two pairs; anterior pair lateral to posterolateral setae. Diameter of anterior eyes for 20 specimens, 7 to 10, mean 8.4; of posterior eyes, 7 to 11, mean 8.3. Diameter of both anterior and posterior eyes of a cotype of *E. signator*, 12.

Dorsal setae: Setae well covered with setules on sides away from body. Posterior setae with slightly fewer setules, tending to terminate in V-shaped clefts, but of the same general form as the other dorsals. In unengorged specimens humerals not distinctly set off from first posthumeral row. Length of humerals of 90 specimens, 37 to 51; of setae near the middle of the first row of posthumerals, 35 to 50; of setae in the posterior group, 27 to 36.

Dorsal formulae for 26 specimens, including a fairly typical specimen from each county:

Oklahoma

Latimer County: 2 .. 11 .. 15 .. 2 .. 12 .. 2 .. 10 .. 8 .. 6

Ohio

Clermont County: 2 .. 10 .. 14 12 7 .. 8 .. 4

Kentucky

Rowan County: 2 .. 10 .. 14 12 12 .. 8 .. 5

North Carolina

Durham County: 2 .. 10 .. 12 12 12 .. 8 .. 4

Orange County: 2 .. 10 .. 13 16 13 .. 8 .. 4

Maryland

Prince Georges County: 2 .. 10 .. 15 .. 2 .. 7+ .. 9 .. 6 .. 5

Pennsylvania

Bedford County: 2 .. 10 .. 12 .. 2 .. 12 10 .. 7 .. 4

York County: 2 .. 10 .. 14 12 10 .. 9 .. 5

Lancaster County: 2 .. 9 .. 14 14 11 .. 10 .. 8

Westmoreland County: 2 .. 10 .. 12 14 12 .. 8 .. 5

Indiana County: 2 .. 10 .. 16 15 13 .. 9 .. 7

Jefferson County: 2 .. 10 .. 14 .. 2 .. 13 14 .. 10 .. 6

Clearfield County: 2 .. 10 .. 14 15 12 .. 9 .. 4

Cameron County: 2 .. 10 .. 14 17 12 .. 9 .. 5

McKean County: 2 .. 10 .. 12 10+ .. 9+ 6 .. 4

Beaver County: 2 .. 10 .. 14 13 9 .. 8 .. 5

Venango County: 2 .. 10 .. 13 .. 2 .. 13 12 .. 9 .. 5

Center County: 2 .. 10 .. 16 14 11 .. 9 .. 5

Union County: 2 .. 10 .. 15 13 10 .. 8 .. 4

Schuylkill County: 2 .. 10 .. 15 13 10 .. 8 .. 4

Lycoming County: 2 .. 10 .. 14 14 9 .. 7 .. 4

Sullivan County: 2 .. 10 .. 13 14 9 .. 9 .. 2

Bradford County: 2 .. 10 .. 15 14 9 .. 7 .. 3

Monroe County: 2 .. 10 .. 14 12 12 .. 9 .. 5

Pike County: 2 .. 11 .. 15 12 9 .. 7 .. 6

Wayne County: 2 .. 10 .. 15 12 10 .. 8 .. 6

Ventral setae: Form of poststernal setae similar to that of the dorsals. Data from 90 specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 49 to 75. Poststernals in a cotype of *E. signator*, 75. Length of first sternals, 36 to 49; of second sternals, 25 to 43; of setae near the middle of the first poststernal row, 19 to 29; of setae in the posterior group, 25 to 36.

Anomalies: Four specimens with three second sternals. One specimen with one rudimentary first sternal bearing two tiny setules.

MATERIAL: Type material of *E. peromysci*, *E. signator*, and *E. brevipes* in the U. S. National Museum; all other specimens in the Duke University collection. From hosts and unattached:

Peromyscus leucopus noveboracensis
Massachusetts

Sturbridge: May 27, 1928, 1
(Holotype).

Pennsylvania

Beaver County: May 1947, 6.
Mercer County: July 1947, 1.
Venango County: Feb. 1948, 4;
Mar. 1948, 3.
Clearfield County: Apr. 1949, 4.

Wood rat

Oklahoma

Wilburton: Mar. 17, 1949, 2
(Cotypes *E. signator*).

Peromyscus leucopus

Maryland

College Park: May 3, 1929, 4
(Cotypes *E. brevipes*).

Pennsylvania

Monroe County: July 1947, 1.

North Carolina

Durham County: Jan. 1948, 3;
May 1948, 9; June 1948, 3;
Sept. 1948, 1; Dec. 1948, 47;
Jan. 1949, 8; Feb. 1949, 13;
Mar. 1949, 6; Apr. 1949, 15;
June 1949, 8; Sept. 1949, 4.
Orange County: Dec. 1948, 3;
May 1948, 3; July 1948, 1;
Nov. 1948, 9; Dec. 1948, 3;
Jan. 1949, 17; Feb. 1949, 21;
Mar. 1949, 27; Apr. 1949, 10;
May 1949, 5; June 1949, 8;
July 1949, 16; Aug. 1949, 2.

Clethrionomys gapperi

Pennsylvania

Wayne County: July 1945, 3.
Monroe County: July 1947, 8.
Pike County: July 1947, 1.
Sullivan County: Oct. 1949, 29.

Clethrionomys gapperi paludicola

Pennsylvania

Venango County: Apr. 1947, 64;
May 1947, 64; Feb. 1948, 15;
Mar. 1948, 87.
Westmoreland County: Feb. 1948,
7.
Jefferson County: Apr. 1948, 8;
May 1948, 33.

Sorex f. fumeus

Pennsylvania

Venango County: Apr. 1947, 2.

Microtus p. pennsylvanicus

Pennsylvania

Venango County: Apr. 1947, 13.
Lycoming County: Jan. 1949, 11.
Clearfield County: Apr. 1949, 9.

Blarina b. brevicauda

Pennsylvania

Venango County: May 1947, 1.
Clearfield County: May 1949, 1.

Tamias striatus

Pennsylvania

Monroe County: July 1947, 1.
Pike County: July 1947, 2.

Peromyscus maniculatus

Pennsylvania

Pike County: July 1947, 1.

- Forest litter
 North Carolina
 Durham County: Feb. 1948, 1.
- Pitymys pinetorum scalopsoides*
 Pennsylvania
 Venango County: Feb. 1948, 8.
 York County: Apr. 1949, 5.
- Surface soil
 North Carolina
 Durham County: Feb. 1948, 1.
 Orange County: Jan. 1950, 8.
- Soil—mammal burrow
 North Carolina
 Durham County: Feb. 1948, 1.
- Peromyscus maniculatus bairdii*
 Pennsylvania
 Venango County: Feb. 1948, 12.
- Peromyscus* sp.
 Pennsylvania
 Westmoreland County: Feb. 1948, 5.
 Cameron County: Sept. 1949, 2.
 Bradford County: Oct. 1949, 1.
- Kentucky
 Rowan County: Aug. 1948, 3.
- Tamias striatus lysteri*
 Pennsylvania
 Venango County: Mar. 1948, 19.
 Jefferson County: May 1948, 27.
 McKean County: July 1948, 1.
- Tamiasciurus hudsonicus loquax*
 Pennsylvania
 Venango County: Mar. 1948, 2.
- Mammal runway
 North Carolina
 Orange County: Mar. 1948, 1.
- Mammal burrow
 North Carolina
 Orange County: Mar. 1948, 1.
- Neotoma magister*
 Kentucky
 Rowan County: Aug. 1948, 2.
- Pennsylvania
 Union County: May 1949, 2.
- Clethrionomys* sp.
 Pennsylvania
 Indiana County: Sept. 1948, 6.
 Cameron County: Sept. 1949, 10.
 Lancaster County: Sept. 1949, 16.
- Monroe County: Sept. 1949, 3.
 Bradford County: Oct. 1949, 4.
 Schuylkill County: Nov. 1949, 4.
 Bradford County: Nov. 1949, 18.
- Tamias striatus ohionensis*
 Ohio
 Clermont County: Oct. 1948, 3.
- Cavities of decayed root systems and under stumps
 North Carolina
 Orange County: Dec. 1948, 12.
 Orange County: Mar. 1949, 3.
 Durham County: Mar. 1949, 2.
 Orange County: Mar. 1950, 10.
- Forest soil
 North Carolina
 Orange County: Dec. 1948, 7.
- Clethrionomys g. gapperi*
 Pennsylvania
 Lycoming County: Jan. 1949, 122;
 Mar. 1949, 35; May 1949, 32.
 Westmoreland County: Jan. 1949, 8.
 Clearfield County: Apr. 1949, 38;
 May 1949, 3.
 Indiana County: Apr. 1949, 14.
 Bedford County: May 1949, 13.
 Union County: May 1949, 58.
 Center County: June 1949, 6.
- Humus under log
 North Carolina
 Orange County: Jan. 1949, 2.
 Durham County: Feb. 1949, 1.
- Peromyscus maniculatus nubiterrae*
 Pennsylvania
 Lycoming County: Mar. 1949, 3.
- Sciurus c. carolinensis*
 North Carolina
 Orange County: Mar. 1949, 2.
- Pitymys p. pinetorum*
 North Carolina
 Durham County: Apr. 1949, 3.
- Synaptomys cooperi stonei*
 Pennsylvania
 Clearfield County: Apr. 1949, 7.
 Indiana County: Apr. 1949, 1.
- Tamias* sp.
 Pennsylvania
 Cameron County: Aug. 1949, 6.

Pitymys sp.

Pennsylvania

Cameron County: Sept. 1949, 3.

Monroe County: Sept. 1949, 1.

Bradford County: Nov. 1949, 14.

Leaf nest in log

North Carolina

Orange County: Oct. 1949, 7.

Durham County: Mar. 1950, 2.

Microtus chrotorrhinus

Pennsylvania

Sullivan County: Oct. 1949, 4.

Ondatra zibethica

North Carolina

Durham County: Nov. 1949, 2.

Soil (7 to 15 cm. depth?)

North Carolina

Orange County: Jan. 1950, 2.

SEASONAL DISTRIBUTION: In North Carolina *E. peromysci* has been collected from hosts in every month of the year except October (fig. 6,c). There is a record of unattached chiggers for October. The species is much more abundant on hosts during the winter and spring months.

GEOGRAPHICAL DISTRIBUTION: The range of *E. peromysci*, based on known collections, extends from Oklahoma in the southwest and North Carolina in the south to Massachusetts in the northeast (fig. 4,a).

DIAGNOSIS: *E. peromysci* can be distinguished by the following combination of characters: Tibiala III present, subterminala and parasubterminala I present, palpal claw with three prongs, no mastitarsala III, sensillae capitate, and scutum with two ridges, one anterior to each pseudostigma. Through the range known at the present time, the shape of the scutum and the characteristic galeal setae will separate *E. peromysci* from other known *Euschöngastia* species.

ECOLOGY: Mr. Neil Richmond has supplied information concerning areas in which *E. peromysci* was collected in Pennsylvania. The chiggers commonly were taken from hosts trapped in situations where hemlock was a dominant tree. Associated trees in the various areas included yellow and black birch, red maple, and oaks. The sites frequently were ravines or slopes with northern or partially northern exposures. Moisture was ample to abundant; springs and brooks were usually present. The forest floor held a moderate to deep layer of humus. Logs and fallen branches were abundant. Most collections were made from *Clethrionomys gapperi*.

In the Duke Forest area *E. peromysci* was taken from its hosts trapped in upland hardwoods (pl. 1) in all exposures and in the narrow bottomlands along streams. Generally the topography of this area is gently rolling, cut by four permanent streams. The forest floor holds a moderate amount of humus, fallen branches, decaying logs, and fallen trees. Stumps in varying stages of decay are common, as are cavities and passageways left by decayed stumps and root systems (pl. 2).

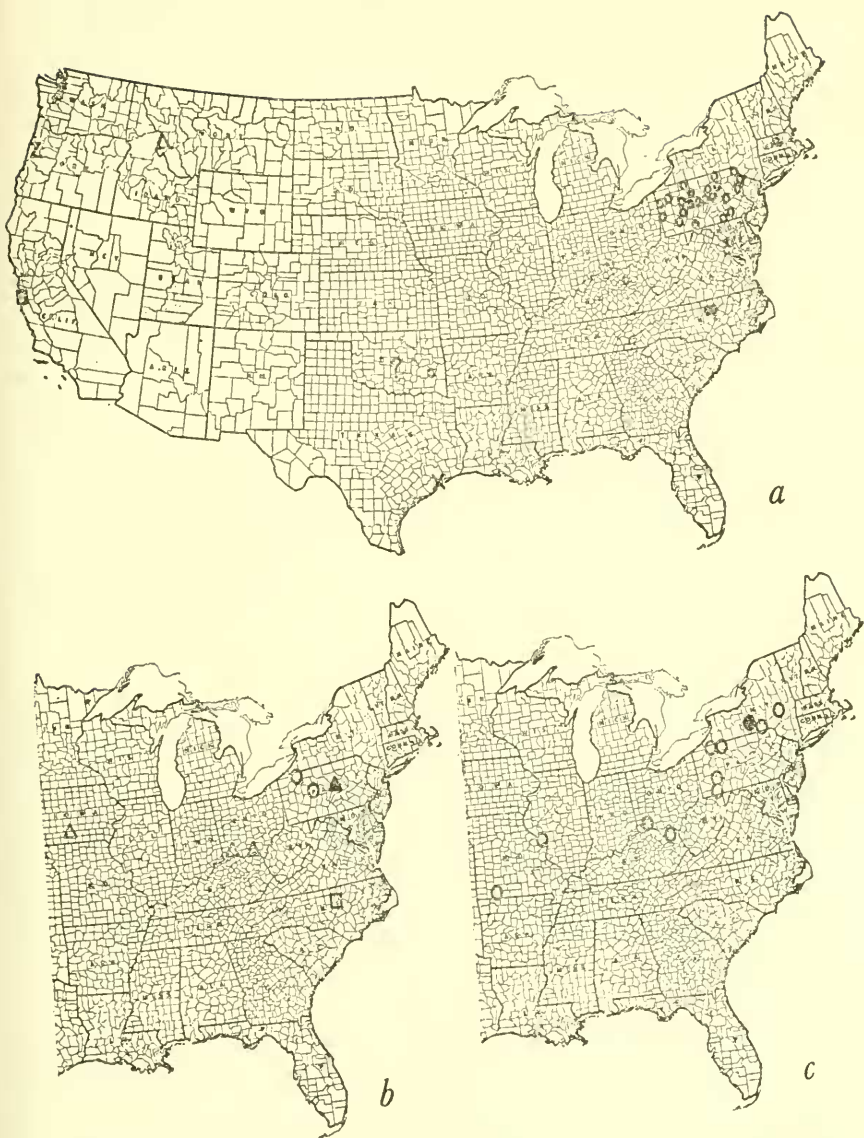


FIGURE 4.—Maps showing: a, distribution of *Euschöngastia lacerta*, □; *E. bigenuala*, X; *E. samboni*, Δ; *E. cordiremus*, Δ; *E. oregonensis*, Z; *E. peromysci*, ○; and *E. trigenuala*, ?. b, distribution of the "rubra" group: *E. rubra*, □; *E. diversa diversa*, Δ and ▲; *E. diversa acuta*, ○; and *E. magna*, ▲; c, distribution of *E. pipistrelli*, ○; and *E. miricoxa* = *E. pipistrelli*, ●.

Evidence indicates that *E. peromysci* is a forest soil dweller in the Duke Forest area. All collections of the unattached, unengorged chiggers have been from forest soil situations (table 5). Whether its principal host, *Peromyscus leucopus*, is a soil dweller in Duke Forest has not been proved, but circumstantial evidence from the traplines—the frequency with which it was trapped around decayed stumps, at the bases of fallen trees, and at small holes in the forest floor—indicates that it is.

Collection records show that *E. peromysci* has been most abundant during the coldest seasons of the year. Figure 6,c, constructed from the occurrence of the chiggers in collections, reflects the trend of seasonal populations. However, three chiggers on one host in a June collection influenced the graph as much as perhaps fifty chiggers on every host of a January collection. The result has been a much-flattened graph without the amplitude that it would have had if based on counts of the chiggers.

Results of preliminary investigations into factors controlling seasonal distribution of *E. peromysci* indicate that it had its peak population during the season when temperatures of air, surface soil, and subsoil (three inches depth) were lowest (fig. 6,e).

EXPLANATION OF FIGURE 5

- a, Variation geographically in the size of scutum in 100 specimens of *Euschöngastia peromysci*. Vertical axis: Size of scutum, PW + ASB + PSB (width + length), in microns. The means are indicated by crosslines. Horizontal axis: Counties, with the number of scuta measured for each: A, Rowan County, Ky.; B, Orange County, N. C.; C, Durham County, N. C.; D, Clermont County, Ohio; E, York County, Pa.; F, Cameron County, Pa.; G, Prince Georges County, Md.; H, Bradford County, Pa.; I, Sullivan County, Pa.; J, Monroe County, Pa.; K, Westmoreland County, Pa.; L, Lancaster County, Pa.; M, Lycoming County, Pa.; N, Union County, Pa.; P, Jefferson County, Pa.; Q, Schuylkill County, Pa.; R, Bedford County, Pa.; S, Clearfield County, Pa.; T, McKean County, Pa.; U, Venango County, Pa.; V, Wayne County, Pa.; W, Indiana County, Pa.; X, Center County, Pa.; Y, Beaver County, Pa.; Z, Pike County, Pa.
- b, Variation geographically in the length of 70 palpal claws of *Euschöngastia peromysci*. Vertical axis: Length of the claws in microns. The means are indicated by crosslines. Horizontal axis: Counties with the number of separate palpal claws measured from each: A, Clermont County, Ohio; B, Rowan County, Ky.; C, York County, Pa.; D, Lancaster County, Pa.; E, Durham County, N. C.; F, Orange County, N. C.; G, Westmoreland County, Pa.; H, Union County, Pa.; I, Lycoming County, Pa.; J, Cameron County, Pa.; K, Bedford County, Pa.; L, Jefferson County, Pa.; M, Venango County, Pa.; N, Clearfield County, Pa.; P, McKean County, Pa.; Q, Sullivan County, Pa.; R, Monroe County, Pa.
- c, Variation geographically in the size of scutum of 20 specimens of *Euschöngastia diversa diversa*. Vertical axis represents size of scutum, PW + ASB + PSB (width + length), in microns. Horizontal axis: A, Clarke County, Iowa; B, Clermont County, Ohio; C, Scioto County, Ohio; D, Union County, Pa. Five scuta were measured for each county. The means are indicated by crosslines.

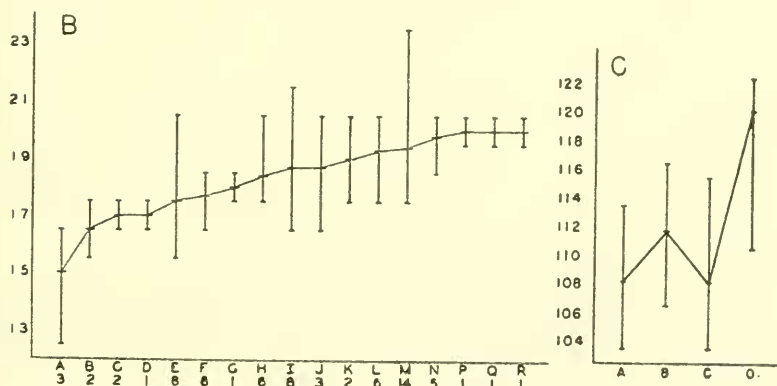
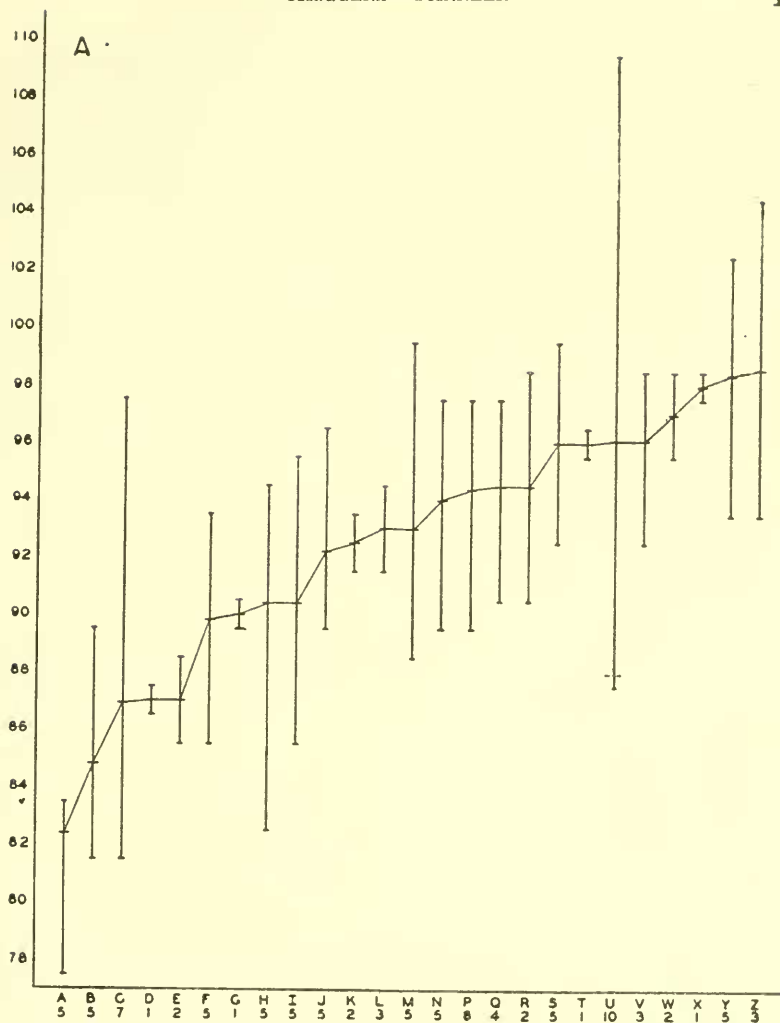


FIGURE 5.—For explanation see facing page.

The population peak coincided generally with the season of least rainfall (fig. 6,f) and highest soil moisture (fig. 6,g).

Laboratory experiments showed the rate of locomotion of *E. peromysci* to be influenced by temperature (fig. 6,h). The rate declined with falling temperatures until locomotion ceased at 0° C. As temperature rose, locomotion was resumed; the first

EXPLANATION OF FIGURE 6

- a, Distribution of setules on the galeal seta of chiggers in the "rubra" group. Vertical axis represents frequency; horizontal axis, number of setules per seta; light solid line, *Euschöngastia rubra*; light broken line, *E. magna*; heavy solid line, *E. diversa acuta*; heavy broken line, *E. diversa diversa*.
- b, Distribution of setules on the lateral seta of the palpal tibia of chiggers in the "rubra" group. Vertical axis represents frequency; horizontal axis, number of setules per seta; heavy broken line, *Euschöngastia diversa diversa*; heavy solid line, *E. diversa acuta*; light broken line, *E. magna*.
- c, Seasonal distribution of *Euschöngastia peromysci* in 91 collections of *Peromyscus leucopus* in the Duke Forest area, September 1947 to December 1949. The 91 collections included 392 specimens of *P. leucopus*. Horizontal axis represents months of the year, with the total number of collections of *P. leucopus* per month; vertical axis, percentage of collections positive for *E. peromysci*.
- d, Seasonal distribution of *Euschöngastia rubra* in 91 collections of *Peromyscus leucopus* in the Duke Forest area, September 1947 to December 1949. The 91 collections included 392 specimens of *P. leucopus*. Vertical axis represents percentage of collections positive for *E. rubra*; horizontal axis, months of the year, with the total number of collections of *P. leucopus* per month.
- e, Mean monthly temperatures in Duke Forest area, September 1947 to March 1950. Vertical axis represents temperature in degrees centigrade; horizontal axis, months of the year; light broken line, air temperature; light solid line, surface soil temperature; heavy solid line, subsurface temperature at three inches depth.
- f, Mean monthly precipitation in Duke Forest area from September 1947 to March 1950. Vertical axis represents inches of precipitation; horizontal axis, months of the year; light line, mean monthly precipitation in inches (yearly average for period, 44.33 inches); heavy line, mean monthly precipitation for central North Carolina for the 61-year period from 1887 to 1947 (yearly average for period, 46.76 inches).
- g, Monthly soil moisture in Duke Forest locality typical of areas in which hosts of *Euschöngastia peromysci* were trapped for the present study. Vertical axis represents soil moisture as a percentage of dry weight; horizontal axis, months of the year; light broken line, percentage of soil moisture in the A₁ horizon, 0 to 2 inches depth; light solid line, percentage of soil moisture in the A₂ horizon, 5 to 7 inches depth; heavy solid line, percentage of soil moisture in the B₂ horizon, 14 to 16 inches depth. The bar diagram gives the monthly rainfall in inches. The graph of soil moisture and the rainfall record covers the period from May 28, 1946, to March 16, 1947. There are no soil moisture records for December 1946 and no rainfall records for May 1946. Data obtained from the thesis of Mr. John B. Sharp, Jr., in the School of Forestry, Duke University, 1947.
- h, Behavior of *E. peromysci* and *T. alfreddugèsi* during falling and rising temperatures. Vertical axis represents rate of locomotion in millimeters per second; horizontal axis, temperature in degrees centigrade; light line, rate of locomotion of *E. peromysci*; heavy line, of *T. alfreddugèsi*. Rates above .80 mm. per second for *T. alfreddugèsi* have been omitted. Calculations by Dr. G. W. Wharton.

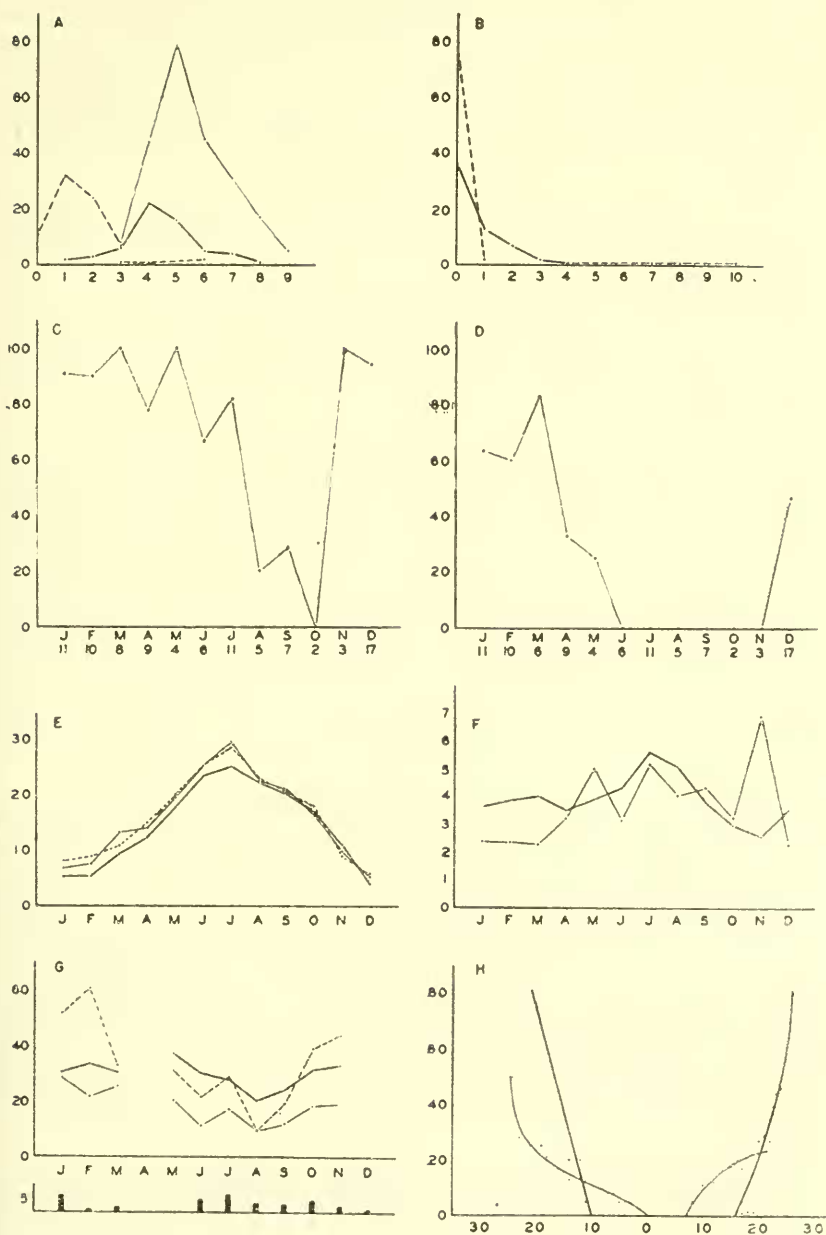


FIGURE 6.—For explanation see facing page.

record was obtained at 7° C. The rate increased with continued rise in temperature. *Trombicula alfreddugèsi*, a chigger with a warm weather distribution, showed a more rapid decline in rate of locomotion with falling temperature and ceased locomotion at 10° C. With rising temperature, *T. alfreddugèsi* resumed locomotion at 16° C.; and its rate rose rapidly as temperature increased.

E. peromysci chiggers were recovered alive from an infested *Peromyscus leucopus* host which had been kept frozen at -4.5° C. for 38 days.

E. peromysci was found attached deep in the ear or in the external auditory meatus of its hosts. After death of the host, the chiggers detached and wandered over the ear (pl. 3) and fur of the host.

DISCUSSION OF ECOLOGY: From the evidence assembled, there could be a correlation between temperature, soil moisture conditions, and the seasonal population peak of *E. peromysci* on hosts. During the colder months when most plant growth has ceased, soil moisture is at its highest. The combination of low temperature and high moisture content of the soil should produce in the soil the most humid conditions of the year. During these months, *E. peromysci* had its greatest incidence on hosts in the Duke Forest area. This conforms with the results of Pearse (1946), who found populations of microfauna in Duke Forest generally to be highest during the colder, moister season.

That there is a correlation between the physiology of *E. peromysci* and its seasonal occurrence is indicated in a comparison of the temperatures at which it and the warm weather *T. alfreddugèsi* ceased locomotion under experimental conditions. The same correlation is evident in the temperatures at which locomotion was resumed. In both phases of the experiment *E. peromysci* carried on activity at much lower temperatures. Experimental evidence showed also that *E. peromysci* can withstand freezing temperatures for extended periods. However, the occasional occurrence of *E. peromysci* in the summer indicates that temperature alone is not the critical factor in its seasonal distribution.

The temperature at which *T. alfreddugèsi* stopped locomotion corresponds well with the findings of Jenkins (1948). In his experiments *T. alfreddugèsi* was not active below 9.5° C. at 60 percent relative humidity. Various authors have indicated the seasonal occurrence of different chiggers. Ewing (1921) pointed out the seasonal distribution of *T. alfreddugèsi*. Audy (1947a)

showed a correlation between seasonal rains and seasonal abundance of *T. deliensis* at Imphal. No literature has been found on physical factors limiting species of *Euschöngastia*.

CULTURES: Sixty-eight cultures of *E. peromysci* were established. Usually cultures were started with nymphs which readily metamorphosed from engorged chiggers held in special plaster-charcoal lined vials. In culture the nymphs lived for varying periods of time, but in general the history of the cultures was uniform. The nymphs steadily declined in activity and died. No later developmental stage was obtained.

Of the variety of culture containers tried, the most satisfactory were made with the bottom intact and a layer of plaster-charcoal poured in. Jars and bottles with bottoms removed and the openings plugged with plaster-charcoal were difficult to make and awkward to use. It was necessary to place them in finger bowls to catch the moisture which escaped through the plaster-charcoal. Jars lined with moist cellulose wadding were unsatisfactory. Nymphs in them soon became immobile. Cultures in jars lined completely with plaster-charcoal were more difficult to examine than those in unlined jars, although nymphs lived well in them. Odd containers used for special purposes were difficult to manage and to observe and gave no promise of being better for the mites than more convenient sizes and shapes. Several sorts of containers were useful. The shallow weighing bottles with openings the full diameter of the bottles permitted unobstructed examination with the dissecting microscope. They were used extensively in feeding trials. However, active mites were sometimes crushed between the long, tapered, ground-glass sealing surfaces. Small, 4-ounce, wide-mouth jars were satisfactory, but control of moisture was more difficult with them than with larger containers. The wide-mouth pint jar seemed best adapted for general use. The chief disadvantage of this jar lay in its being too deep for observation with the dissecting microscope. This difficulty was removed when the layer of plaster-charcoal was made sufficiently thick. Also, the extra absorbent material made control of moisture less critical. Solid metal lids and screw bands regularly supplied with the jars were found to be the most satisfactory covers for the cultures. Wide-mouth pint jars about one-third filled with plaster-charcoal and fitted with the solid lids made compact and useful units.

Nymphs were placed in culture jars without adding a material through which they could move when experiments to find an acceptable food were being carried out. When given the opportunity, the mites would quickly enter soil or any loose medium

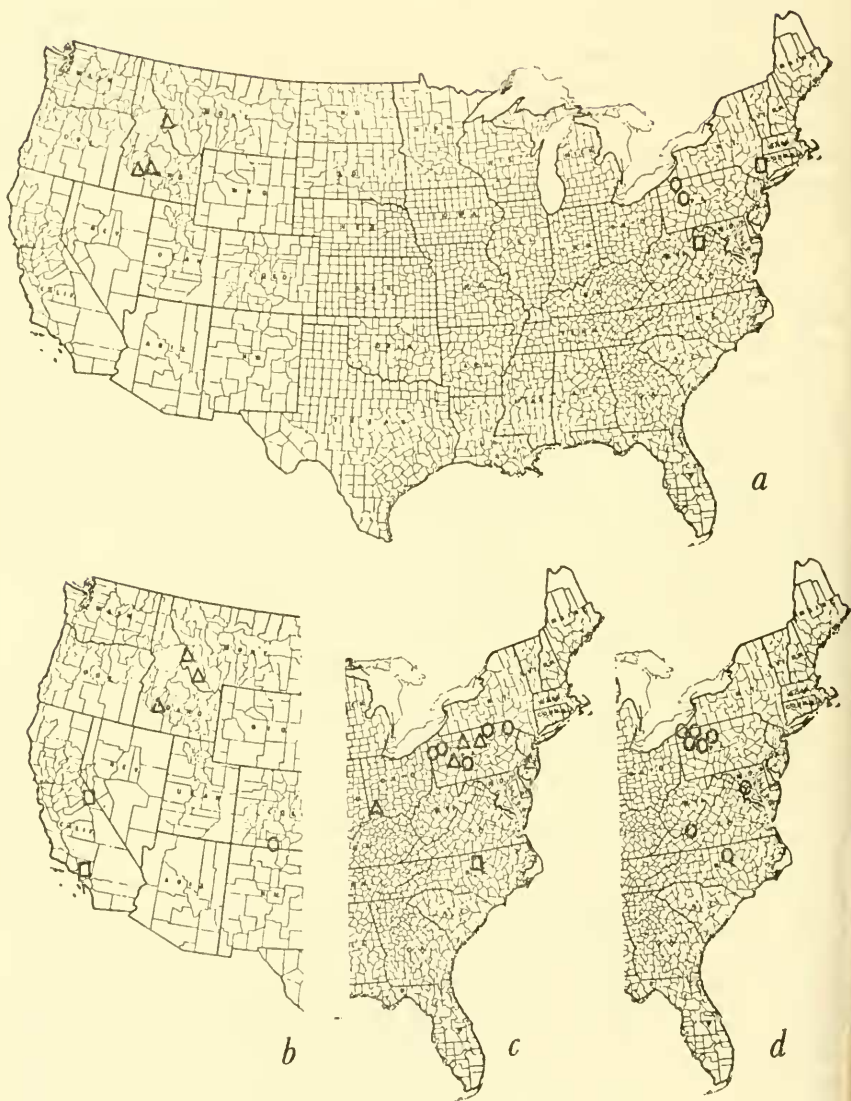


FIGURE 7.—Maps showing: a, distribution of *E. luteodema*, Δ ; *E. marmota*, \circ ; and *E. hamiltoni*, \square . b, Distribution of *E. californica*, \square ; *E. criniticollis*, Δ ; and *E. guntheri*, \circ . c, Distribution of *E. carolinensis*, \square ; *E. crateris*, \circ ; and *E. chioensis*, Δ . d, Distribution of *E. blarina*, \circ .

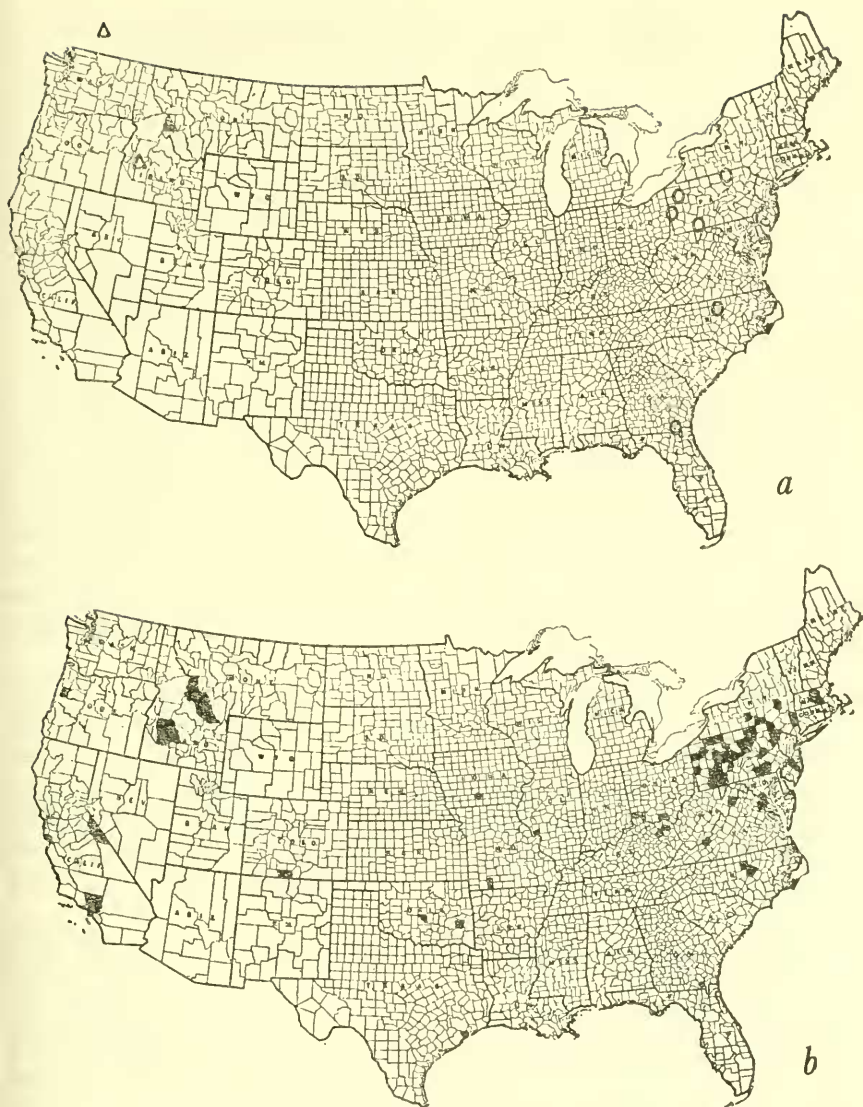


FIGURE 8.—Maps showing: *a*, Distribution of *E. sciuricola*, \triangle and \blacktriangle ; *E. setosa*, \circ ; and *Euschingastia* sp., \blacktriangle . One record of *E. sciuricola* in British Columbia, Canada. *b*, Distribution of the genus *Euschingastia*, based on known collections, in the United States. The Canadian locality and that of the Mexican species are not shown. Each county in the United States from which a collection has been recorded is shown in black. The Okefenokee Swamp location is indicated by a dot—county not known.

placed in the jars. Usually some medium was added. Soil, the various soil mixtures, humus, and organic debris had certain disadvantages. Frequently the surfaces became covered with fungus. The nymphs often entered these media and were never seen again. Such media were difficult and unsatisfactory to move for examining the cultures. Vermiculite was the most satisfactory medium. It formed a soft, loose stratum through which the mites could move easily. It could be rolled about easily for examining the culture without damaging the mites. Apterous insects, sometimes kept in cultures, survived and multiplied in vermiculite. Nymphs seemed to survive better in vermiculite than in other media.

Fungus frequently developed in cultures but never became a serious problem. When cultures were carefully moistened and excess water avoided, fungus was retarded. Its control with vermiculite was easier than with other media. Rolling vermiculite in the culture jar broke up mycelia and reduced growth. With both soil and vermiculite, adding *Onychiurus* sp. to cultures was usually effective in controlling fungus. These small, apterous insects fed on the fungus. Apparently they were not harmful to chiggers or nymphs.

Cultures maintained at 30° C. seemed to follow the same pattern as those held at room temperature. Nymphs steadily died out. Nymphs held at 5° to 10° C. were very sluggish in their movements when examined, but they moved more rapidly after being at room temperature for a few minutes. Room temperature seemed more satisfactory than other temperature ranges tried. Cultures, excepting those held at definite temperatures, were kept in a darkened cabinet.

Evidence is not adequate to determine whether a proper food for nymphs of *E. peromysci* was found. So far as was determined by direct observation, the nymphs rejected almost all food offered. *Aedes aegypti* eggs were offered regularly to most cultures. Under observation *E. peromysci* nymphs appeared to try to feed on these eggs on only one occasion. On the day one culture was established, two nymphs were observed manipulating eggs. Body contractions and expansions, typical of feeding nymphal or adult trombiculids, occurred. The efforts ceased in a few minutes. Examination of one of the eggs showed no openings or any other evidence of successful feeding by the nymph. Four successful acts of feeding on freshly dissected *Aedes aegypti* ovaries and eggs were observed. The first nymph to feed stopped at a scratch mark made by the needle in the plaster-charcoal base in placing

a dissected ovary in the culture. Later the nymph located the ovary and fed for 15 to 20 minutes. It changed its position twice during feeding. Flowing movements were observed in the fluid mass of the ovary immediately in front of the nymph's gnathosoma. Bubbles or fluid materials of varying densities were observed moving posteriorly through the middle of the gnathosoma. Observations on the other three acts were similar, but in two of these the mass of the ovary was pushed up to a nymph pattering in the region of a needle scratch. On one other occasion a nymph inserted its gnathosoma into the mass of a dissected ovary and remained in position for about a minute. No signs of feeding could be determined. It disengaged its gnathosoma and lay on its side while seeming to clean its appendages. On a number of other occasions nymphs ignored dissected *Aedes* ovaries.

One culture was established with two nymphs obtained from larvae engorged on a white mouse in the laboratory. Vermiculite was used as a medium through which the mites could move. *Sinella curviseta*, a collembolan, was maintained in this culture. These insects laid eggs and reproduced. When the culture was flooded 163 days after it had been established, one plump, living nymph was recovered. It can be inferred that this nymph fed on some stage of *Sinella curviseta*. This record of 163 days represents also the longest time a nymph was kept alive.

As indicated in the preceding paragraph, *E. peromysci* larvae engorged successfully on white mice in the laboratory. The unengorged larvae were obtained from forest soil materials by means of Berlese funnels. One such experiment was used as a start to obtain information concerning the time involved in various stages of the life cycle. Numerous wild-caught, unengorged larvae were placed on a white mouse. One engorged chigger was obtained on the fourth day and seven engorged chiggers on the seventh day after exposure. These eight chiggers were preserved. On the eighth day after exposure of the mouse to the larvae, 15 engorged chiggers were recovered. These were placed in a special vial. Four days later these chiggers were immobile, entering the nymphochrysalis stage. Nine days after this stage had been reached, one nymph was found in the vial. On the 11th day after the immobility of the larvae, the vial contained nine nymphs. No other nymphs or nymphochrysalids were found. These nymphs were held in the special vial without addition of any food. Thirty-six days later the vial contained one dead and eight living nymphs.

It was demonstrated, also, that *E. peromysci* would attach to man. Fifteen unattached, unengorged *E. peromysci* larvae were

obtained from forest soil materials through Berlese funnels. These were distributed in seven cells which were then attached to the palmar surfaces of a man's forearms. When the applications were examined $4\frac{1}{2}$ to 7 hours later, two chiggers were missing from the cells. Of the chiggers found in the cells, nine were dead and four were alive. One of the living chiggers, examined $5\frac{1}{2}$ hours after application, was attached to the skin. It was fastened securely in the center of a small reddish spot about 2 mm. in diameter. Apparently it was attached at a pore, not at the base of a hair. When first observed, it was wet with water or perspiration; all legs projected sharply posteriorly and it did not move. Nudged repeatedly with a dissecting needle, it was thrust about, pivoting on its gnathosoma. In a short time it began to move its legs in the air. Several trials were made with a dissecting needle before the chigger was removed from the point of attachment and preserved. All other chiggers also were preserved.

REMARKS: The known range of *E. peromysci* gives it the widest distribution of any North American *Euschöngastia*. It varies within limits through its range. Certain variations, which have been charted, seem to have geographical continuity. The frequency with which it has been collected indicates *E. peromysci* is the most common *Euschöngastia* to be found on small mammals east of the Mississippi River.

Examinations of the holotype of *E. peromysci* (Ewing, 1929) and of the cotypes of *E. signator* (Ewing, 1931) and *E. brevipes* (Ewing, 1931) showed all three species to conform to the same morphological pattern. The ranges of *E. peromysci* and *E. brevipes* have been united by subsequent collections. Collections have not yet united this eastern range with that of *E. signator*, but the newer records from Ohio, Kentucky, and North Carolina point toward the continuity. Certain morphological characters of *E. signator* do appear at the limits of variation of the species, so that a possibility of subspeciation remains. However, on the basis of morphology and geographical distribution, the three species are here considered to be the same and *E. brevipes* and *E. signator* to be synonyms of *E. peromysci*.

9. *Euschöngastia cordiremus* Brennan

FIGURE 4,a; PLATES 6, 12

Euschöngastia cordiremus Brennan, 1948, pp. 465, 470, 471, 477, figs. 5,a-d, 11.

DESCRIPTION: Size: Length engorged, 410 to 580; width, 225 to 350.

Shape: Long ovoid or oval.

Color: Yellow (Brennan, 1948).

Gnathosoma: Seta on palpal femur strong, curved, well covered with strong setules on convex curvature. Genua seta thinner, with a few long, slender setules alternately arranged. Dorsal seta on palpal tibia slender with few, slender, alternate setules; lateral seta slender with one to three slender setules; ventral seta with setules spaced alternately in two dorsal rows. Palpal claw strong, slightly curved, three-pronged, the two smaller accessories arising together on the basal half. Galeal seta rather small with two or three setules. Chelicera typical; base heavy; blade smoothly curved with small subapical dorsal tooth and a larger ventral tooth. Punctae on palpal coxa and cheliceral base.

Legs: Leg I with two slender genualae and a microgenuala, two tibialae with a microtibiala, a rather small spur with microspur about half the length of the spur distal, a subterminala, a parasubterminala, and a pretarsala. Leg II with a single slender genuala, two shorter tibialae, a rather long, slender spur with microspur near the base, usually anterior, and a pretarsala. Leg III with a slender genuala and a slender tibiala. Nonspecialized setae generally with setules shorter and finer than in *E. peromysci*. All leg segments punctate.

Scutum: Shape generally similar to that of *E. peromysci* but more fully rounded. Setae well covered with short setules, but less densely than in *E. peromysci*. Pseudostigmata well behind a line between the posterolateral setae, deep and globular. Enlarged portion of sensilla ovoid or with tips truncate; well covered with setules on anterior surface, fewer on posterior surface; pedicel rather long, enlarging into the head. A strong ridge arises anteromedial to each pseudostigma, curving anteriorly, laterally, and posteriorly to the posterior margin of the scutum; the two ridges sometimes continuous medially. Surface punctate. Cuticular striae apparent over posterior margin.

Standard data of the five specimens studied from Ravalli County, Mont.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
49	61	13	25	23	8	25	28	45	32
47	57	13	22	25	12		25	46	30
48	58	13	18	26	13	25	25	48	
50	61	11	22	27	10	28	28	44	21*
50	61	13	19	26	14	27	32	48	32

*Expanded portion only.

Eyes: Two pairs, anterior pair lateral to posterolateral setae. Diameter of anterior eyes, 10 to 11, mean 10.4; of posterior eyes, 9 to 11, mean 10.4.

Dorsal setae: Shafts of setae moderately heavy; rather short setules cover shaft well but not densely; anteriorly, the side adjacent to body is nude; posteriorly, setules distributed around the shaft; posteriors end bluntly or with V-clefts. Length of humerals, 43 to 50; of setae near the middle of the first post-humeral row, 38 to 44; of setae in the posterior group, 33 to 38.

Dorsal formulae of the five specimens studied from Ravalli County, Oreg.:

2	..	10	..	13	..	..	15	..	8	..	6	..	2
2	..	10	..	13	..	..	11	..	8	..	8	..	7
2	..	10	..	12	..	..	14	..	9	..	7	..	5
2	..	10	..	12	..	..	12	..	8	..	6	..	5
2	..	10	..	10	..	2	..	10	..	10	..	7	..	5

Ventral setae: Poststernals similar to dorsals. Number of first sternals, 2; of second sternals, 4; of poststernals, 57 to 71. Length of first sternals, 35 to 42; of second sternals, 25 to 32; of setae near the middle of the first poststernal row, 21 to 24; of setae in the posterior group, 32 to 42.

MATERIAL: Five paratypes studied. The four collected Oct. 16, 1945, are in the U. S. National Museum; the one collected Feb. 6, 1946, was borrowed from Rocky Mountain Laboratory. Specimens from hosts, all in Montana:

<i>Peromyscus m. artemisiae</i>	|	<i>Peromyscus</i>
Ravalli County: Oct. 16, 1945, 4.	|	Ravalli County: Feb. 6, 1946, 1.

SEASONAL DISTRIBUTION: Brennan (1948) reported collections in February, May, and October.

GEOGRAPHICAL DISTRIBUTION: *E. cordiremus* has been collected only in Ravalli County, Mont. (fig. 4,a).

DIAGNOSIS: *E. cordiremus* is the only species with four setae in the second sternal row. It is quite similar to *E. peromysci*. In *E. cordiremus* the enlarged portion of the sensilla is less sharply distinct from the pedicel than it is in *E. peromysci*. The galeal seta of *E. cordiremus* lacks the bristlelike appearance which characterizes the galeal seta of *E. peromysci*.

REMARKS: Advantage has been taken of the similarity of *E. cordiremus* to *E. peromysci* in the description of the former. The two might easily be considered to form a group.

The "rubra" group

The "rubra" group, as it is now known, is composed of three new species, with one of these divided into two subspecies. Diagnostic features of the group include: Tibiala III present, two genualae I, subterminala and parasubterminala I present, papal claw with three prongs, galeal seta usually branched, two pairs

of distinct eyes, a scutum marked by three joined ridges, cuticular striae folded over the posterior margin of the scutum, and capitate sensillae. As the genus is known at the present time, the form of the ridges on the scutum is sufficient to set off the "*rubra*" group from other North American species, as follows: Two inverted, somewhat V-shaped ridges—one anterior to each pseudostigma—with a third ridge extending anteriorly around the anterior median seta connecting the apexes of the first two.

10. *Euschöngastia rubra*, new species

FIGURES 4,b, 6,a,d; PLATES 2, 4, 7, 13

DESCRIPTION: Size: Length, 276 to 722; width, 165 to 554.

Shape: Ovoid in unengorged specimens in life, broader posteriorly, becoming oval with engorgement. Unengorged specimens preserved on slides, ovoid; engorged specimens preserved on slides, broadly oval.

Color: Light red in unengorged specimens, becoming pink, orange, and yellow with increasing engorgement; always with deep red eyes.

Gnathosoma: Seta on palpal coxa with strong fringe of setules on outer curvature. Strong, forward-curving seta on palpal femur

TABLE 7.—Distribution of setules on the galeal setae by pairs of setae for 121 specimens of *Euschöngastia rubra*

Number of setules	Frequency	Number of setules	Frequency	Number of setules	Frequency
3-4	2	5-5	15	6-8	3
3-5	3	5-6	11	6-9	1
3-6	1	5-7	6	7-7	3
3-x	2	5-8	2	7-8	6
4-4	4	5-9	1	7-x	4
4-5	21	5-x	5	8-8	1
4-6	8	6-6	8	8-9	3
4-7	4	6-7	5	8-x	1
4-x	1				

(Each figure is the number of setules on one seta of the pair; x indicates a seta broken off)

with numerous setules evenly distributed except on concave margin, which tends to be nude. Strong curving seta on palpal genu with numerous setules in about four alternate rows on its convex curvature. Dorsal seta on palpal tibia strong with setules in one or two rows on its outer curvature; lateral seta shorter, strongly pectinate or with setules alternately arranged on its outer curvature; ventral seta long and strong with numerous setules alternately arranged over the longitudinal dorsal half of the shaft. Palpal claw strong, curved, three-pronged with median prong longest and strongest; accessories strong, arising about one-half

the length of the claw from its base. Palpal tarsus typical, feathered setae with strong setules. Palpal coxa and femur punctate. Galeal seta strong, usually slightly curved inward, strongly pectinate with number of setules variable (table 7 and fig. 6,a) with five the central tendency. Basal segment of chelicera heavy, laterally angulate, strongly punctate; blade strong, curved, with distinct subapical dorsal and ventral teeth.

Legs: Leg I with two strong genualae of moderate length and a fine microgenuala; two typical tibialae with a fine microtibiala closely posterior to the more distal of the two; a strong spur slightly proximal to middle of the tarsus with microspur about half the length of the spur distal, single strong subterminala and parasubterminala, and typical pretarsala. Leg II with a strong genuala and two tibialae of moderate length; tarsus with long spur and proximal microspur, pretarsala typical. On leg III a single genuala and a single tibiala, both strong and of moderate length. Nonspecialized setae moderately long with numerous long, curving setules in alternate pattern forming a brush along the outer surfaces. Legs taper slightly. All leg segments with punctae.

Anomaly: On one specimen a spurlike striated seta in addition to the normal tibiala was located on the distal dorsal surface of one tibia III.

Scutum: Narrower between anterolateral setae, increasing slightly in width to posterolaterals, and broadly rounded posteriorly. Anterolateral corners extended, causing the anterior margin to be strongly incurved. Anterolateral and posterolateral setae approximately equal in length; anteromedian much shorter, set back from anterior margin, usually ascending from depression on scutum and bent sharply in mounting; setae with numerous slender setules, similar to dorsals, distributed around the shafts. Surface punctate and strongly marked with ridges and depressions. Usually with one or two slightly larger pits or pores posterolaterally. Anterior to each of the two pseudostigmata a V-shaped ridge, apex anterior; outer leg curved, extending past posterolateral seta and blending into posterior margin; medial leg almost straight. A third ridge extending anteriorly around the anterior median seta is continuous with the apexes of the first two. Pseudostigmata close together, posterior to a line drawn between the posterolaterals, set into the bases of the ridges near the ends of the medial legs. Sensillae capitate; heads distinctly set off from pedicels and covered by short setules; heads usually lie within the depressions behind the ridges. Cuticular striae over portion posterior to pseudostigmata.

In life, posterolateral setae project posteriorly at a slight angle to the body; anterolaterals project posterolaterally at a slight angle, converging medially; anteromedian seta projects almost perpendicularly from the scutum, giving it an anterior inclination caused by the somewhat anterior exposure of the scutum.

Anomalies: In each of two specimens a posterolateral seta together with its setal base was lacking.

Standard data of the type specimen from Orange County, N. C.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
48	62	19	17	35	10	63	37	61	30

Summary of standard data of 16 specimens, including the type, from Orange, Durham, and Wake Counties, N. C. (AL's from 15 specimens, AM's from 15 specimens, S's from 6 specimens):

AW 42-54, mean 48.5; PW 58-66, mean 61.9; AP 17-23, mean 20.5;
 SB 11-20, mean 15.8; ASB 29-38, mean 33.8; PSB 10-14, mean 11.9;
 AL 50-63, mean 59.9; AM 29-38, mean 33.9; PL 52-65, mean 59.3;
 S 25-30, mean 25.8.

Eyes: Two pairs. Anterior eyes lateral to posterolateral setae, distance varying with engorgement. Anterior and posterior eyes almost contiguous in unengorged specimens, becoming separated with engorgement. Diameter of anterior eyes of 14 specimens, 11 to 13, mean 12.4; of posterior eyes 10 to 13, mean 11.6.

Anomaly: In one specimen no posterior eyes were apparent; on one side there were apparently two eyes transversely arranged.

Dorsal setae: Numerous setae in six posthumeral rows plus a few irregular posteriors. Longitudinal portion of seta opposite body densely covered with fine setules of moderate length; portion adjacent to body tends to be nude. Posterior setae terminate bluntly or with V-clefts, perhaps with fewer setules than the anteriors but of the same form. Length of humerals of 13 specimens, 54 to 61; of setae from the middle of the first posthumeral row, 50 to 55; of setae from the posterior group, 32 to 38.

Dorsal setal formulae of 10 specimens from North Carolina:

Orange County:	2 .. 12 .. 15 15 15 .. 9 .. 7 .. 4 (type)
	2 .. 13 .. 17 .. 1 .. 15 14 .. 8 +14
	2 .. 12 .. 17 .. 1 .. 16 14 .. 9 +10
	2 .. 13 .. 15 15 13 .. 9 +11
	2 .. 13 .. 15 .. 2 .. 17 .. 2 .. 12 .. 10 .. +9
Durham County:	2 .. 12 .. 17 15 .. 1 .. 13 +16
	2 .. 14 .. 16 .. 2 .. 15 13 .. 8 +12
	2 .. 12 .. 15 .. 2 .. 16 .. 3 .. 13 .. 8 +11
	2 .. 14 .. 16 16 .. 2 .. 14 .. 10 .. +6
Wake County:	2 .. 12 .. 16 .. 2 .. 12 .. 1 .. 11 .. 9 .. +7

Ventral setae: Form of poststernals similar to that of dorsals. Data from 13 specimens: Number of first sternals, 2; of second

sternals, 2; of poststernals, 75 to 93. Length of first sternals, 53 to 61; of second sternals, 35 to 40; of setae near the middle of the first poststernal row, 28 to 33; of setae in the posterior group, 32 to 41.

Anomaly: Three setae in the second row of sternals on a single specimen.

MATERIAL: Type, USNM 1991. Specimens from hosts and unattached, all from North Carolina:

Peromyscus leucopus

Orange County: Dec. 1947, DU-3;
Jan. 1948, DU-4; Mar. 1948,
DU-1; Apr. 1948, DU-3; Dec.
1948, DU-3; Jan. 1949, DU-6,
Afr-1, Aus-1, CEF-10; Feb.
1949, DU-10, CEF-7; Mar. 1949,
DU-12; Apr. 1949, DU-1; May
1949, DU-1.

Durham County: Dec. 1947, DU-1;
Jan. 1948, DU-2; Feb. 1948,
DU-5; Dec. 1948, DU-18, RML-5,
CM-3, KU-3; Jan. 1949, DU-8;
Feb. 1949, DU-3; Mar. 1949,
USNM-2, DU-3; Apr. 1949,
DU-4.

Wake County: Feb. 1948, DU-6.

Surface soil

Durham County: Feb. 1948, DU-1;
Apr. 1948, USNM-1.

Peromyscus nuttalli

Wake County: Feb. 1948, DU-1;
Mar. 1948, DU-3.

Under old stump

Orange County: Dec. 1948, DU-1.

Sylvilagus floridanus mallurus

Orange County: Feb. 1949, CEF-2.

Base of hollow tree

Orange County: Mar. 1949,
USNM-1.

Under decaying stumps

Orange County: Mar. 1949, DU-1;
Jan. 1950, USNM-Type +1,
DU-3.

Soil (19 to 30 cm, depth?)

Orange County: Jan. 1950,
USNM-4.

SEASONAL DISTRIBUTION: All collections of *E. rubra* were made during the months of December through May (fig. 6,d). Dates of first and last collections of each season:

Season	First collection	Last collection
1947-1948	Dec. 25, 1947	Apr. 25, 1948
1948-1949	Dec. 12, 1948	May 1, 1949
1949-1950	Jan. 7, 1950	- - -

GEOGRAPHIC DISTRIBUTION: *Euschöngastia rubra* has been collected only in Durham, Orange, and Wake Counties, N. C. (fig. 4,b).

DIAGNOSIS: *Euschöngastia rubra* can be distinguished from the other species of its group by the strongly branched lateral seta on the palpal tibia, by the different shape of its scutum with its smaller size and stronger ridges and depressions, and by its more southern range.

ECOLOGY: In the Duke Forest area the ecology of *E. rubra* appears to be similar to that of *E. peromysci*. Both species of chiggers commonly occurred on the same host specimens. How-

ever, *E. rubra* was confined strictly to the season during which soils were colder and more moist (fig. 6,d).

E. rubra was found attached deep in the ears or in the external auditory meatus of its hosts.

CULTURES: Seven cultures were started with *E. rubra* nymphs. These were in weighing bottles or wide-mouth pint jars. One weighing bottle was lined with moist cellulose wadding. On this the nymphs soon became immobile and all were dead in less than 13 days. Other weighing bottles and the jars had a base of plaster-charcoal. No medium for the mites was used in one culture. In other cultures soil or vermiculite in combination with other materials was used. *Aedes* eggs or soil arthropods were offered as food. In no culture was there any further development. Engorged larvae from hosts readily metamorphosed into nymphs in special vials. But nymphs in culture apparently refused all food offered and soon died.

LIFE HISTORY: A very limited amount of life history information was obtained from the culture data. It was found that nymphs can develop from engorged larvae in 15 days or less. One living nymph was recovered from a culture which had been established with four nymphs 29 days earlier.

REMARKS: The type specimen of *E. rubra* is an unattached, unengorged specimen collected from the debris under a small, decayed removable stump (pl. 2). *E. rubra* has been named from the color of unengorged specimens.

11. *Euschöngastia magna*, new species

FIGURES 4,b, 6,a,b; PLATES 7, 13

DESCRIPTION: Size: Engorged length, 630 to 660; width, 370 to 475.

Shape: Broad oval.

Gnathosoma: General similarity to *E. rubra*. Lateral setae on palpal tibiae with four and eight setules on one specimen, seven and ten on the second specimen (fig. 6, b). Palpal claw similar to that of *E. rubra* but straighter, longer, and stouter. Tarsal spur longer than in *E. rubra*. Galeal setae with four and six setules on one specimen, three and six on the second specimen (fig. 6,a).

Legs: Similar to *E. rubra*.

Scutum: General outline much like that of *E. rubra*, about the same proportionate taper between anterolaterals and posterolaterals, rounded posteriorly. About one-fifth larger over-all than *E. rubra*; largest scutum in the group. Ridges and depressions less strong than in *E. rubra*.

Standard data for the two specimens from Union County, Pa.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
62	78	24	22	38	14	70	43	69	35 (Type)
59	76	24	19	35	15	67	40	67	25*

*Head of sensilla only.

Eyes: Two pairs; diameters of both pairs, 12 to 13.

Dorsal setae: Similar in form to those of *E. rubra*; anterior and posterior setae of the same form. Total number greater than in *E. rubra*, chiefly because of two extra rows of setae. The extra rows are shown in italic in the dorsal formulae. Length of humerals, 61 to 63; of setae near the middle of the first post-humeral row, 50 to 55; of setae in the posterior group, 41 to 43.

Dorsal formulae for the two specimens from Union County, Pa.:

2 .. 15 ..	6 .. 17 ..	8 .. 13 ..	3 .. 11 ..	10 +10 ..	..	(Type)
2 .. 14 ..	6 .. 18 ..	11 .. 14 ..	.. 9 ..	9 .. 7 ..	2 .. 2	

Ventral setae: Poststernals similar to those of *E. rubra*; number of first sternals, 2; of second sternals, 2; of poststernals, 107. Length of first sternals, 58 to 67; of second sternals, 40 to 41; of setae near the middle of the first poststernal row, 34; of setae in the posterior group, 38 to 43.

MATERIAL: Type, USNM 1992. Specimens from hosts, all from Pennsylvania:

Neotoma magister

Union County: May 16, 1949,
USNM-Type.

Clethrionomys g. gapperi

Union County: May 24, 1949,
DU-1.

GEOGRAPHIC DISTRIBUTION: *E. magna* has been collected only in Union County, Pa. (fig. 4,b).

DIAGNOSIS: *E. magna* can be distinguished from the other species in the group by the larger size of its scutum and the extra rows of setae in the dorsal formula.

REMARKS: The type specimen of *E. magna* was found in association with *E. peromysci* and *E. diversa diversa* on *Neotoma magister*. *E. magna* has been named for the larger size of the scutum.

12. *Euschöngastia diversa*, new species

Euschöngastia diversa is a northern form, divided into two subspecies. Morphologically it differs from the more southern *E. rubra* by a general reduction in the number of setules on the setae of the gnathosoma, fewer body setae which differ in form on the anterior and posterior portions of the body, and a somewhat larger scutum which tends to be rectangular in general outline.

In the study of the "*rubra*" group, at first all forms were placed together. It later became apparent that these specimens from the north were different from those collected in Duke Forest. From this "difference" their name is derived.

12a. *Euschöngastia diversa diversa*, new subspecies

FIGURES 4,b, 5,c, 6,a,b; PLATES 7, 14

DESCRIPTION: Size: Length, 290 to 635; width, 185 to 430.

Shape: Ovoid to broad oval.

Color: As in *E. rubra*.

Gnathosoma: General form as in *E. rubra*; fewer setules on all setae. Seta on palpal genu with about two to twelve setules in one or two rows on convex curvature. Lateral seta on palpal tibia

TABLE 8.—Distribution of setules on the lateral seta of the palpal tibia by the pair of setae per specimen for 40 specimens of *E. diversa diversa*.

Number of setules	Frequency
0-0	36
0-1	2
0-x	1
x-x	1

(Each figure is the number of setules on one seta of the pair; x indicates a seta broken off)

usually nude (table 8 and fig. 6,b). Palpal claw similar to that of *E. rubra*; two accessory prongs arising on proximal half, clearly interrupting the smooth contour of the claw. Galeal seta with reduced number of setules, usually one or two (table 9, and fig. 6,a). Chelicera similar to that of *E. rubra*.

Anomaly: One specimen with four prongs on one palpal claw.

Legs: Generally similar to *E. rubra*.

Scutum: Generally somewhat wider and shorter than in *E. rubra*. Less taper between anterolaterals and posterolaterals than in *E. rubra*; width between anterolaterals proportionately greater.

TABLE 9.—Distribution of setules on the galeal seta by the pair of setae per specimen for 40 specimens of *E. diversa diversa*.

Number of setules	Frequency	Number of setules	Frequency	Number of setules	Frequency
0-0	2	1-2	9	2-3	5
0-1	5	1-3	1	2-x	1
0-2	1	1-x	1	3-x	1
0-x	1	2-2	4	x-x	1
1-1	8				

(Each figure is the number of setules on one seta of the pair; x indicates a seta broken off)

Posterior margin not so rounded as in *E. rubra*, tending to be straight or with a shallow concavity in the middle. The whole scutum appearing somewhat rectangular. Ridges and depressions not so marked as in *E. rubra*, appearing more flat. Apparently a tendency within the species for scutum to become larger from west to east (fig. 5,c).

Standard data of the type specimen from Clermont County, Ohio:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
60	67	19	19	35	11	64	39	64	23*

*Head of sensilla only

Summary of standard data, including the type, of five specimens from each geographic region—Clark County, Iowa; Clermont County, Ohio; Scioto County, Ohio; and Union County, Pa. (AM's from 19 specimens, S's from 5 specimens):

AW 54-66, mean 58.1; PW 63-73, mean 67.2; AP 16-22, mean 18.5;
 SB 16-22, mean 18.9; ASB 25-37, mean 33.3; PSB 10-14, mean 11.9;
 AL 54-72, mean 65.6; AM 31-39, mean 35.6; PL 54-70, mean 61.6;
 S 26-31, mean 29.4.

Eyes: Two pairs, subequal in size. Diameters (from 14 specimens) of anterior eyes, 10 to 13, mean 11.9; of posterior eyes, 9 to 13, mean 11.5.

Dorsal setae: Arranged in six or seven rather clearly defined transverse rows with a few irregularly placed on the posterior; total number fewer than in *E. rubra*. Form of setae over most of the body similar to *E. rubra*. Posterior setae with heavier shafts; setules shorter, heavier, somewhat scalelike, reduced in numbers and exposing portions of the shaft; free ends blunt or with V-clefts. Length of humerals, 54 to 64; of setae near the middle of the first posthumeral row, 50 to 63; of posterior setae, 41 to 56.

Dorsal formulae for five specimens from each geographical region:

Region:

Clarke County, Iowa:	2	..	14	..	15	..	..	15	..	..	10	..	10	..	6	..	+8
	2	..	14	..	16	..	..	14	..	..	9	..	9	..	8	..	4
	2	..	12	..	15	..	..	13	..	..	9	..	9	..		..	+7
	2	..	14	..	14	..	..	15	..	..	11	..	10	..	7	..	3
	2	..	14	..	14	..	..	15	..	..	9	..	8	..	8	..	+5
Clermont County, Ohio:	2	..	12	..	13	..	..	12	..	..	11	..	7	..		..	+8 (Type)
	2	..	12	..	17	..	..	12	..	..	10	..	10	..	5	..	
	2	..	13	..	14	..	..	15	..	..	12	..		..		..	+16
	2	..	12	..	14	..	..	13	..	..	12	..	8	..		..	+7
	2	..	13	..	14	..	..	14	..	..	11	..	11	..	6	..	4
Scioto County, Ohio:	2	..	12	..	14	..	..	13	..	..	11	..	8	..		..	+7
	2	..	12	..	14	..	..	12	..	..	10	..	7	..	7	..	7
	2	..	12	..	15	..	..	13	..	..	9	..	8	..	9	..	4
	2	..	14	..	14	..	..	14	..	..	10	..	11	..	9	..	6
	2	..	12	..	16	..	..	12	..	..	12	..	10	..	6	..	1
Union County, Pa.:	2	..	12	..	16	14	..	1	..	10	..	8	..	6	..	1
	2	..	12	..	15	..	..	12	..	..	9	..	8	..		..	+9
	2	..	13	..	18	..	1	..	13	9	..	7	..	6	..	5
	2	..	13	..	?	..	..	?	..	..	?	..	?	..	?	..	?
	2	..	12	..	17	..	..	14	..	..	?	..	?	..	?	..	?

? indicates setae could not be counted.

? indicates setae could not be counted.

Ventral setae: Form and arrangement similar to *E. rubra* except for posteriors which have fewer, shorter, scalelike setules. Total number fewer than in *E. rubra*. Data from 19 specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 62 to 80. Length of first sternals, 39 to 60; of second sternals, 30 to 45; of setae from the middle of the first row of poststernals, 28 to 35; of posterior setae, 42 to 59.

MATERIAL: Type, USNM 1993. Specimens from hosts:

Field mouse	<i>Microtus ochrogaster ohionensis</i>
Iowa	Ohio
Clarke County: Mar. 18, 1936, USNM-6.	Scioto County: Mar. 10, 1949, USNM-3, DU-5, CEF-1.
<i>Microtus p. pennsylvanicus</i>	<i>Clethrionomys g. gapperi</i>
Ohio	Pennsylvania
Clermont County: Mar. 15, 1948, KU-1.	Union County: May 15, 1949, CEF-1; May 27, 1949, RML-2; May 27-28, 1949, DU-1.
<i>Synaptomys cooperi saturatus</i>	<i>Neotoma magister</i>
Ohio	Pennsylvania
Clermont County: Mar. 15, 1948, USNM-Type, DU-2, CEF-1.	Union County: May 16, 1949, DU-2.
<i>Microtus ochrogaster</i>	
Ohio	
Clermont County: Jan. 3, 1949, DU-3, Afr-1, Aus-1; Jan 4, 1949, Du-4, CEF-1, CM-2; Jan. 16, 1949, DU-2.	

SEASONAL DISTRIBUTION: *E. diversa diversa* has been collected only during the winter and spring months, January, March, and May.

GEOGRAPHIC DISTRIBUTION: The known range of *E. diversa diversa*, as it is here defined, extends in a band from Clarke County, Iowa, in the west, through Clermont and Scioto Counties, Ohio, to Union County, Pa., in the east (fig. 4,b).

DIAGNOSIS: *Euschöngastia diversa diversa* can be distinguished from other members of the *E. rubra* group by the following combination of characters: Nude lateral seta on palpal tibia, reduced number of setules on the galeal seta, the form of the palpal claw which branches in the proximal half with accessory prongs interrupting the contour, and by its geographical range.

ECOLOGY: Mr. Woodrow Goodpaster supplied information concerning the Ohio collections.

The *Synaptomys* from which *E. diversa diversa* was collected in Clermont County, Ohio, was trapped in a meadow of timothy, bluegrass, blackberry, goldenrod, and sweet clover. Small elms and locust were present in the meadow. The *Microtus* were taken in the same locality or in rolling timothy-clover meadows. In

Scioto County, Ohio, the hosts were trapped in timothy meadows invaded by dewberry, blackberry, greenbriar, sumack, and locust. In all situations the soil was clay-loam and the ground was wet with winter rains. Hosts were trapped in runways on the surface.

The Scioto County collections were made from two specimens of *Microtus* which had been kept frozen very hard by the collector for five and seven days before the chiggers were removed. The chiggers were alive when removed.

Collectors recorded that *E. diversa diversa* infested the ears of the hosts.

12b. *Euschöngastia diversa acuta*, new subspecies

FIGURES 4,b, 6,a,b; PLATES 4, 7, 14

DESCRIPTION: Size: Length, 270 to 675; width, 170 to 430.

Shape: Ovoid to oval.

Color: As in *E. rubra*.

Gnathosoma: Tendency to fewer setules on palpal setae than in *E. rubra*, but not so much reduced as in *E. diversa diversa*. Seta on palpal genu with 8 to 20 or more setules in two or three

TABLE 10.—Distribution of setules on lateral seta of the palpal tibia by the pair of setae per specimen for 31 specimens of *E. diversa acuta*

Number of setules	Frequency	Number of setules	Frequency	Number of setules	Frequency
0-0	13	1-1	1	2-2	1
0-1	7	1-2	3	2-3	1
0-2	1	1-x	1	3-4	1
0-x	2				

(Each figure is the number of setules on one seta of the pair; x indicates a missing seta)

rows on the outer curvature. Lateral seta on palpal tibia usually nude (table 10; fig. 6,b), but not to the degree found in *E. diversa diversa*; setules frequently tiny. Palpal claw longer and smoother than in both *E. rubra* and *E. diversa diversa*; the two accessory

TABLE 11.—Distribution of setules on the galeal setae by the pair of setae per specimen for 31 specimens of *E. diversa acuta*

Number of setules	Frequency	Number of setules	Frequency	Number of setules	Frequency
1-4	2	3-7	1	5-5	3
2-4	2	4-4	3	5-6	1
2-x	1	4-5	6	5-7	2
3-3	1	4-6	2	6-8	1
3-4	2	4-7	1	6-x	1
3-5	1	4-x	1		

(Each figure is the number of setules on one seta of the pair; x indicates a missing seta)

prongs arise on distal half and usually lie close, interrupting the taper very little. Galeal seta with fewer setules (table 11; fig. 6,a) than in *E. rubra* but more than in *E. diversa diversa*; tendency to four or five setules.

Legs: Form of legs and form and distribution of all setae as in *E. diversa diversa*.

Anomalies: Distal tibiala I on one leg of a single specimen replaced by a microtibiala. The tibiala III lacking on one leg of a single specimen.

Scutum: With the characters of the group and similar to *E. diversa diversa* with the tendency to squareness at the postero-lateral corners somewhat more pronounced.

Standard data of the type specimen from Warren County, Pa.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
58	67	19	19	31	11	52	33	63	28

Summary of standard data, including the type, of ten specimens, five from each of Clearfield and Warren Counties, Pa. (AM's from nine specimens, S's from four):

AW 55-67, mean 59.6, PW 63-73, mean 68.8, AP 17-22, mean 19.1,
 SB 16-23, mean 20.1, ASB 31-36, mean 32.9, PSB 8-11, mean 9.9,
 AL 52-72, mean 61.7, AM 27-38, mean 33.4, PL 57-69, mean 62.4,
 S 28-32, mean 30.3.

Eyes: Two pairs. Anterior pair lateral to posterolateral setae. Diameter of anterior eyes of eight specimens, 10 to 13, mean 12; of posterior eyes, 10 to 13, mean 12.2.

Dorsal setae: Form, number, and arrangement similar to *E. diversa diversa*. Length of humeral setae of ten specimens, 54 to 62; of setae near the middle of the first posthumeral row, 50 to 55; of posterior setae, 38 to 47.

Dorsal formulae for five specimens from each geographic region:

Clearfield County, Pa.:	2 .. 12 .. 14 .. 12 .. 10 .. 8 .. 6 .. 2	
	2 .. 12 .. 11 .. 13 .. 11 .. 9 .. 7 .. 3	
	2 .. 13 .. 13 .. 13 .. 13 .. 9 .. 7 .. 3	
	2 .. 13 .. 12 .. 14 .. 9 .. 8 .. . +5	
	2 .. 12 .. 14 .. 12 .. 10 .. 9 .. . +6	
Warren County, Pa.:	2 .. 12 .. 13 .. 12 .. 10 .. 8 .. 2 ..	(Type)
	2 .. 12 .. 16 .. 12 .. 11 .. 10 .. . +7	
	2 .. 12 .. 12 .. 12 .. 9 .. 9 .. 4 .. 2	
	2 .. 12 .. 13 .. 14 .. 8 .. 8 .. . +6	
	2 .. 12 .. 14 .. 14 .. 10 .. 9 .. . +6	

Ventral setae: Form, number, and arrangement similar to *E. diversa diversa*. Data from 10 specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 44+ to 72. Length of first sternals, 47 to 58; of second sternals, 33 to 40; of setae near the middle of the first poststernal row, 27 to 33; of posterior setae, 38 to 45.

MATERIAL: Type, USNM 1994. Specimens from hosts, all from Pennsylvania:

Zapus h. hudsonius

Warren County: June 17, 1948,
DU-1, CEF-3; June 18, 1948,
USNM-Type+5, DU-1.

Microtus p. pennsylvanicus

Clearfield County: Apr. 16, 1949,
CEF-1; Apr. 24, 1949, CEF-3.

Synaptomys cooperi stonei

Clearfield County: Apr. 22, 1949,
CEF-1.

Napeozapus i. insignis

Clearfield County: May 4, 1949,
DU-4, RML-2, CM-2; May 5,
1949, DU-5, KU-1, Afr-1, Aus-1.

SEASONAL DISTRIBUTION: *E. diversa acuta* has been collected only during the spring months, April, May, and June.

GEOGRAPHIC DISTRIBUTION: *E. diversa acuta* has been collected in two counties, Clearfield and Warren, in northwestern Pennsylvania (fig. 4,b).

DIAGNOSIS: *E. diversa acuta* can be distinguished from other members of the *E. rubra* group by the form of its palpal claw, the reduced number of setules on the lateral seta of the palpal tibia, the relatively high number of setules on the galeal seta, and by its geographic range.

ECOLOGY: According to Mr. Neil Richmond, the hosts in Warren County, Pa., were collected in a hay meadow and in the surrounding thickets of blackberry, elm, hawthorn, and pin cherry. The area was located on a flat, well-drained floodplain of the Allegheny River. The summer season was well advanced. Over 100 *Microtus* and 70 to 80 *Peromyscus*, as well as *Blarina*, *Condylura*, and *Tamiasciurus*, were trapped with few or no chiggers.

The chiggers were attached deep in the pinna on *Zapus* and to the scalp below and behind the pinna.

CULTURES: Two cultures of *E. diversa acuta* nymphs were established. One culture was in a pint jar with the bottom removed and the opening plugged with plaster-charcoal. In the second a base of plaster-charcoal was poured into the intact jar. Forest soil was used as a medium in both. *Aedes aegypti* eggs were offered as food in both. No further development of the nymphs occurred.

LIFE HISTORY: From collection dates and culture records it was determined that engorged larvae of *E. diversa acuta* metamorphosed into nymphs in 12 days or less. One living nymph was observed in a culture 29 days after the culture had been established.

REMARKS: *E. diversa acuta* has been named from the form of its palpal claw.

The forms comprising the "*rubra*" group are obviously related. They are bound together by their morphology, their seasonal distribution, and their geographic range. However, variations occur within the pattern of the group, and the morphological differences are correlated with geographic distribution so that the separate

forms become apparent. Morphologically the group is split in two by the shape of the scutum and the form and number of the body setae. The split is emphasized by the variation in the number of setules on the galeal setae (fig. 6,a) and the lateral seta on the palpal tibiae (fig. 6,b). Thus, *E. rubra* and *E. magna* go together and are distinctly set off from *E. diversa*. Evidence that this cleavage represents a real difference at the specific level and not a geographical variation at the subspecific level is obtained in the collections from Union County, Pa. Here the ranges of the morphologically distinct *E. diversa* and *E. magna* coincide.

The collections from Union County are meager; and, since they are pivotal in determining the number of species in the "*rubra*" group, some consideration should be taken concerning the possibility that the two forms are variants of the same species. Of the eight specimens from Union County, six have been placed in *E. diversa* and two in *E. magna*. The *E. diversa* specimens represent four collections of two host species. The *E. magna* specimens represent two collections of the same two host species. Both forms were taken once from the same host animal. Although the sampling of the chigger population is small, it is well dispersed; and it seems unlikely that a minor group of genetic variants would comprise as much as 25 percent of such a sample. The occurrence of both forms on a single host is evidence that they are not ecophenotypes. The morphological distinctness of the two forms with the absence of intergrades indicates they are not variants.

Within the basic pattern of *E. diversa* two populations are separable geographically. The known geographic ranges of the two populations are separated by only one county in Pennsylvania. Based on the combination of morphology and range, the best explanation of the relationship between the two populations seems to be that they are geographic races of the same species. Two subspecies have been erected for them in *E. diversa*.

The relationship between those forms here named *E. rubra* and *E. magna* is by no means clear. The difference in size of scuta is not great when the geography is considered. However, at the present time the two forms can be separated by the size of the scutum. The extra rows of dorsal setae in the northern form separate it from the southern form. There are no collections between North Carolina and Union County, Pa., to indicate trends of variations or extent of ranges. Future collections may show that the two forms are distinct or that they fall within the limits of a single species. In the present state of knowledge of the genus it seems best to recognize forms that are clearly separable. In this

way they add to the total picture and make possible more rapid progress.

The "*rubra*" group is unique in the genus for variability in a relatively small geographic area. Further collections, particularly from the region of Union County, Pa., and the areas between the known geographic ranges, are needed to define the systematics of the species more sharply. Also, with so variable a group it is probable that other related forms will be discovered in areas not yet investigated.

13. *Euschöngastia guntheri* (Radford)

FIGURE 7,b; PLATES 6, 15

Neoschöngastia guntheri Radford, 1942, pp. 76, 77, fig. 101; 1947a, pp. 596-598, figs. 23, 24; 1947b, p. 275.

Euschöngastia guntheri, Brennan, 1948, vol. 34, p. 473.—Fuller, 1952, pp. 182, 183.

DESCRIPTION: Size: Length of the single specimen studied, 400; width, 335.

Shape: Broad oval.

Gnathosoma: Long curving seta on palpal femur with sparse, rather long setules alternately arranged. Seta on palpal genu shorter, curved, with a few long setules in rows on its outer curvature. Dorsal seta on the palpal tibia long, arching, with a row of setules; lateral seta thin with two fine setules. Palpal claw long and smooth; three prongs, median prong longest. Galeal setae with four and seven long setules, respectively. Cheliceral base heavy, longer than broad; blade strong, curved; subapical dorsal and ventral teeth distinct. Palpal coxa and femur and base of chelicera punctate.

Legs: Leg I with two genualae and a microgenuala, two tibialae and a microtibiala, a typical spur, a microspur, a subterminala, a parasubterminala, and a pretarsala; all striated setae rather short. Leg II with a single genuala, two tibialae, a spur with proximal microspur, and a pretarsala; spur long, the others rather short. Leg III with one rather small genuala; no tibiala. Nonspecialized setae on leg I rather long on proximal segments beyond the trochanter, shorter distally, with numerous short curving setules on the surfaces opposite the leg. On leg II, dorsally particularly, setae tend to have fewer, straighter setules. Both sorts of nonspecialized setae on leg III. Two setae on coxa III. Leg segments stout. Claws on tarsi I and II small in proportion to the size of the tarsi. All leg segments with punctae.

Anomaly: One coxa I with two setae.

Scutum: Twice as broad as long. Pointed at the posterolateral corners. Anterior margin approximately straight with antero-

lateral corners extended slightly anteriorly and a median convexity adjacent to the anteromedian seta. Lateral margins concave, diverging posteriorly. Posterior margin with a slight concavity just medial to each posterolateral corner and broadly convex posteriorly. Anterolateral setae and posterolateral setae on the extensions at the corners; anteromedian seta close to the anterior margin. Setae rather heavy. Pseudostigmata moderately separated, considerably posterior to a line drawn between the posterolaterals. Sensillae clavate; pedicel distinct; expanded portion pyriform; setules on anterior surface of head smoother, those on posterior surface fewer and more offstanding. Anterior to each pseudostigma a long crescentic ridge. Punctae rather widely spaced. Two larger pits or pores about halfway between the posterolateral and the pseudostigma visible on one side.

Standard data of the single specimen studied from Antonito, Colo.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
71	103	21	32	34	13	34	36	64	34

Eyes: Two pairs lateral to the posterolateral corners. Diameter of anterior eyes, 12; of posteriors, 11.

Dorsal setae: Rather heavy; well clothed with rather short setules; the same form throughout; numerous; tend to occur in bands rather than in rows. Length of a humeral, 57; of a seta from the middle of the first posthumeral row, 54; of one from the posterior group, 36.

Dorsal formula of the single specimen from Antonito, Colo.:

$$2 \dots 12 \dots 12 \dots +26 \dots +27 \dots +15 \dots +14$$

Ventral setae: Form similar to that of the dorsals. Number of first sternals, 2; of second sternals, 2; of poststernals, about 100. Length of a first sternal, 54; of a second sternal, 44; of a seta near the middle of the first poststernal row, 32; of a seta from the posterior group, 38.

MATERIAL: Borrowed from the Rocky Mountain Laboratory. Specimen from host:

Ochotona sp.

Antonito, Colo., Sept. 9, 1931, 1.

DIAGNOSIS: *E. guntheri* is the only species in the genus which characteristically has two setae on coxa III.

14. *Euschöngastia criceticola* Brennan

FIGURE 7, b; PLATES 7, 15

Euschöngastia criceticola Brennan, 1948, pp. 465, 473-474, 476, 477, figs. 6, 13.

DESCRIPTION: Size: Length, 400 to 455; width, 245 to 285.

Shape: Ovoid.

Color: Yellow (Brennan, 1948).

Gnathosoma: Seta on palpal femur strong, curved, moderately clothed with setules. Seta on genu smaller, pectinate. Dorsal seta on tibia pectinate; lateral seta on tibia slender, with one or two slender setules, or nude; ventral seta slender, with about three alternate rows of setules on the dorsal side of the shaft. Palpal claw curved, with three prongs, median prong longest. One specimen with five prongs on the palpal claw. Galeal seta with several setules. Cheliceral base typical; blade strong, curved, subapical dorsal and ventral teeth distinct. Palpal coxa punctate; base of chelicera indistinctly punctate.

Legs: Leg I with two genualae, a microgenuala, two tibialae, a microtibiala, a middorsal spur and a distal microspur, a subterminala, a parasubterminala, and a pretarsala, all rather short. Leg II with a genuala and two tibialae, all very short; spur long with microspur anterior to it; pretarsala of normal size. Leg III with a very small genuala; no tibiala. Nonspecialized setae on leg I generally with a fringe of short, curved setules; nonspecialized setae on legs II and III mostly with fewer and straighter setules. All coxae punctate; some distal segments punctate.

Anomaly: Both subterminalae I and both parasubterminalae I lacking in one specimen.

Scutum: Over twice as wide as long. Anterior margin slightly concave between anteromedian seta and anterolaterals. Lateral margins concave, diverging posteriorly. Posterior margin convex posterior to pseudostigmata, usually slightly concave between them; exact outline somewhat obscured by cuticular striae. Anteromedian seta close to the anterior margin. Setae rather short, covered with short setules. Pseudostigmata a moderate distance apart; posterior to a line drawn between the posterolateral setae; deep, in marked depressions under the medial margins of strong horseshoe-shaped ridges. Sensillae long clavate; each enlarging from the base without distinct pedicel; widest about four-fifths the length from the base; covered by setules which extend down to the pseudostigma; setules longer and smoother on the anterior surface. Surface of scutum with punctae, usually most apparent in medial region, usually one or two larger pits or pores near ridge medial to posterolateral setae. Cuticular striae encroach upon the posterior margin and appear to cross the anterolateral corners posterior to the anterolateral setae.

Summary of standard data of four specimens from Beaverhead County, Mont. (AM's from two specimens, S's from three):

AW 59-63, mean 61.3; PW 79-82, mean 80.5; AP 15-19, mean 17; SB 21-27, mean 24.8; ASB 22-22, mean 22; PSB 13-16, mean 13.8; AL 32-41, mean 36.3; AM 29-31, mean 30; PL 44-46, mean 45.3; S 31-35, mean 32.7. Width of head of sensilla in two specimens, 14 and 16.

Eyes: Two pairs lateral to the posterolateral setae. Diameter of anteriors, 10 to 13, mean 12; of posteriors, 10 to 12, mean 10.7.

Dorsal setae: Uniformly covered with short setules on side opposite body, any on edges closer to body appear heavier; all setae of the same general pattern. Length of humerals, 48 to 57; of setae near the middle of the first posthumeral row, 42 to 48; of setae in the posterior group, 32 to 34.

Dorsal formulae for four specimens from Beaverhead County, Mont.:

2	..	13	..	13	..	14	..	10	..	5	..	4	..	4
2	..	12	..	14	..	13	..	9	..	6	..	4	..	
2	..	12	..	14	..	12	..	8	..	6	..	4	..	
2	..	13	..	13	..	13	..	9	..	8	..	3	..	

Ventral setae: Poststernals generally similar to dorsals in form. Number of first sternals, 2; of second sternals, 2; of poststernals, 41 to 54. Length of first sternals, 42 to 48; of second sternals, 28 to 35; of setae near the middle of the first poststernal row, 25 to 32; of setae in the posterior group, 30 to 32.

MATERIAL: Two of the paratypes in the Rocky Mountain Laboratory, the other two in the U. S. National Museum. Specimens from host:

Peromyscus

Beaverhead County, Mont., Sept. 3, 1945, 4.

SEASONAL DISTRIBUTION: Brennan (1948) reported collections in February, June, and September.

GEOGRAPHIC DISTRIBUTION: Brennan (1948) lists collections from Ravalli and Beaverhead Counties, Mont., and from Elmore County, Idaho (fig. 7,b).

DIAGNOSIS: *E. criceticola* can be distinguished by the following combination of characters: No tibiala III; palpal claw usually with three prongs; scutum with two strong, horseshoe-shaped ridges, each inclosing a pseudostigma in a deep depression; and a thin lateral seta, nude or with one or two thin setules, on the palpal tibia. *E. criceticola* is quite similar morphologically to *E. californica*. On *E. criceticola* the lateral seta on the palpal tibia is slender with one or two thin setules or nude. This seta is strongly branched on *E. californica*. The character of the non-specialized leg setae differs in the two species. The nonspecialized

setae on leg I of *E. criceticola* bear a fringe of short curved setules. These setules of *E. californica* are stronger and much longer.

REMARKS: The occurrence of one specimen with five prongs on the palpal claw among the four paratypes studied might indicate that this feature is quite variable. However, the same specimen was anomalous in lacking the subterminala and parasubterminala I on both legs. Brennan (1948) lists nine specimens in the type series and states the palpal claw is rarely with more than three prongs. In eastern species with a three-pronged palpal claw the character is very constant. To determine whether a five-pronged palpal claw represents normal variability or anomaly within *E. criceticola*, further collections and study are required.

15. *Euschöngastia californica* (Ewing)

FIGURE 7,b; PLATES 8, 16

Schöngastia californica Ewing, 1925b, pp. 261, 262.

Neoschöngastia californica, Ewing, 1931, p. 5.—Radford, 1942, p. 72.—Sig

Thor and Willmann, 1947, pp. 310, 312–313.

Euschöngastia californica, Fuller, 1948, p. 108; 1952, p. 183.

DESCRIPTION: Size: Length of the single specimen studied, 420; width, 225.

Shape: Long oval.

Gnathosoma: Seta on palpal femur strong, curved, with long setules on outer curvature. Seta on palpal genu strong, curved, with three or four rows of long setules. Dorsal seta on palpal tibia with two alternate rows of setules; lateral seta with six long setules; ventral seta with long setules. Palpal claw with three strong prongs; median prong longest and strongest; accessories arise about a third the length of the claw from its base. Galeal seta with five setules, most projecting dorsally. Chelicera with typical base, only the subapical ventral tooth determinable. No punctae discernible.

Legs: Leg I with two genualae and a microgenuala, two tibialae and a microtibiala, a rather long spur with distal microspur, a subterminala, a parasubterminala, and a pretarsala. Leg II with a genuala, two tibialae, a long, rather slender spur with microspur proximal and slightly anterior, and a pretarsala. Leg III with a genuala. Nonspecialized setae generally long with long, curving setules. No punctae seen.

Scutum: Anterior margin slightly concave between antero-median seta and each anterolateral. Lateral margins short, concave, diverging posteriorly. Posterior margin deeply convex. All setae close to the margin; anterolaterals and posterolaterals

on slightly extended corners; anteromedian on an anterior convexity. Setae well covered with setules. Pseudostigmata well behind a line drawn connecting posterolaterals; deeply set. Sensillae with expanded, cordiform heads well covered with setules on the anterior surface, sparsely covered on the posterior surface. A ridge apparent anterior to each pseudostigma, the sensilla lying in a depression behind it. No punctae seen.

Standard data of the single specimen from Los Angeles, Calif. (expanded portion of sensilla only measured):

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
47	60	14	20	27	12	50	32	44	20

Eyes: Two pairs, prominent; anterior pair lateral to the posterolateral setae. Diameters of both anterior and posterior eyes, 12.

Dorsal setae: Nude adjacent to body. Setules rather short. Free ends blunt or V-cleft. Length of humeral, 40; of a seta near the middle of the first posthumeral row, 38; of a seta from the posterior group, 34.

Dorsal formula of the single specimen from Los Angeles County, Calif.:

2 .. 12 .. 10 .. 2 .. 10 .. 2 .. 9 .. 6 .. 4

Ventral setae: Free ends of anterior setae fine, becoming heavier and more blunt posteriorly. Number of first sternals, 2; of second sternals, 2; of poststernals, about 48. Length of a first sternal, 44; of a second sternal, 29; of a seta near the middle of the first poststernal row, 20; of a seta in the posterior group, 33.

MATERIAL: All specimens in the U. S. National Museum. Specimens from hosts:

Ground squirrel
Topaz, Calif., 4.

Neotoma sp.
Los Angeles County, Calif., Jan. 13,
1933, 1.

DIAGNOSIS: *E. californica* closely resembles *E. criceticola*, from which it can be distinguished by the more strongly branched lateral seta on the palpal tibia and by the different character of the nonspecialized leg setae. In *E. criceticola* the tendency for the body setae to terminate bluntly is less marked. In *E. californica* the expanded portion of the sensilla is shorter and there is less taper into the pedicel than in *E. criceticola*.

REMARKS: In the specimen upon which this redescription has been based, the number of nonspecialized setae on the palpal tarsus could not be determined.

Ewing's original description of *Euschöngastia californica* was

made from four specimens collected from a ground squirrel at Topaz, Mono County, Calif. It is a description of a species that could be included in *Euschöngastia*, as the genus is known. Probably the description is not adequate to identify any species today. The type specimens (USNM 893) cannot be deciphered by the methods now in use.

The specimen described here was collected from *Neotoma* sp. in Los Angeles County, Calif. So far as can be determined, its morphology is consistent with the original description. It was identified by Ewing as *E. californica*. No useful function can be attained by permitting names to lapse into questionable status when there is reasonable evidence that they apply to specimens at hand. The name *E. californica* is available. There is evidence that the specimen being considered here is conspecific with the type material. The name *E. californica* is here applied to this specimen, which is made the basis for a redescription of the species. This specimen, in the U. S. National Museum, is on the slide marked "C. E. F. X."

The "*luteodema*" group

The "*luteodema*" group is composed of two species, *E. luteodema* and *E. marmotae*. The group is distinguished by the following combination of characters: No tibiala III, palpal claw with three prongs, a single seta on coxa III, nonspecialized setae on the legs with rather few and heavy, straight setules. The scutum is wide and relatively flat; any ridges are weak. The sensillae are clavate on distinct pedicels. The palpal setae have a reduced number of setules. Dorsal setae have relatively few and heavy setules. There is a tendency for the dorsal setae of the first three posthumeral rows to occur out of line, or in bands rather than in rows.

16. *Euschöngastia luteodema* Brennan

FIGURE 7,a; PLATES 7, 17

Euschöngastia luteodema Brennan, 1948, pp. 470, 472-473, figs. 5A-B, 12.

DESCRIPTION: Size: Engorged length, 370 to 610; width, 300 to 640.

Shape: Broad oval, sometimes broader than long.

Color: Pale yellow (Brennan, 1948).

Gnathosoma: Seta on palpal coxa with few setules. Seta on palpal femur strong, with a few strong setules. Seta on genu with about three to seven setules. Dorsal seta on tibia with about three to six setules; lateral seta nude; ventral seta with about

five long setules. Palpal claw strong; three-pronged; median prong longest and heaviest; prongs arise near middle or on distal half. Galeal seta nude or with one, two, or three setules. Chelicera large; distinct subapical dorsal and ventral teeth on blade. Palpal coxa and cheliceral base usually without apparent punctae, occasionally with very small, faint punctae.

Legs: Leg I with two slender genualae and a microgenuala, two tibialae, the more proximal longer, and a microtibiala, a rather small spur and a distal microspur, a subterminala, a parasubterminala, and a pretarsala. Leg II with two rather small tibialae, a slender spur with proximal microspur, and a pretarsala. No genuala II. Leg III with no specialized setae. Non-specialized setae with few setules. Empodium long. Usually no punctae apparent, occasionally fine and faint on coxae.

Anomaly: One specimen with two setae on one coxa III.

Scutum: Shape somewhat variable, about twice as wide as long. Anterior margin convex between anteromedian seta and the anterolaterals. Lateral margin straight or slightly concave, diverging posteriorly. Posterior margin convex; or convex posterior to the pseudostigmata and slightly concave between them; or made up of three rather straight lines joined by short curves near the pseudostigmata. Posterolateral corners somewhat pointed. The five setae set close to margin; setae rather heavy with relatively few setules. Pseudostigmata posterior to a line drawn between the posterolateral setae. Sensilla long clavate, but with distinct pedicel, widest about four-fifths the length from the base; distal end rounded or slightly pointed; covered with setules on the anterior surface, setules fewer and shorter on posterior surface. Usually without ridges anterior to pseudostigmata; two specimens with ridges suggested. No punctae apparent. Usually with two or three small pits on each side between the posterolateral seta and the pseudostigma.

Summary of standard data of five specimens, three from Ravalli County, Mont., and two from Camas County, Idaho (AM's from four specimens, S's from three):

AW 60-70, mean 64.6; PW 84-102, mean 92.2; AP 16-25, mean 20;
SB 29-42, mean 32.8; ASB 24-33, mean 29.2; PSB 10-13, mean 12;
AL 39-48, mean 42.8; AM 38-43, mean 39.8; PL 58-62, mean 60.2;
S 34-44, mean 40. Width of head of sensilla in three specimens, 14, 15, and 16.

Eyes: Two pairs lateral to the posterolateral setae. Diameter of anterior pair, 11 to 13; of posterior pair, 9 to 12.

Dorsal setae: Rather heavy with relatively few heavy setules.

Setae numerous, tend to occur in bands rather than in rows anteriorly. Length of humerals, 50 to 67; of setae near the middle of the first posthumeral row, 41 to 56; of setae in the posterior group, 33 to 49.

Dorsal formulae for five specimens:

Montana

Ravalli County:	2	..	21	..	22	..	10	..	8	..	5	..	4
	2	..	19	..	16	..	13	..	7	..	4	..	?
	2	..	19	..	17	..	11	..	8	..	8	..	6

Idaho

Camas County:	2	..	17	..	17	..	13	..	7	..	6	..	
	2	..	21	..	19	..	11	..	3	..	12	..	7 .. 6 .. 4

Ventral setae: Sternals with finer setules, other ventral setae similar in form to dorsals. Data from five specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 40 to 50. Length of anterior sternals, 41 to 51; of second sternals, 32 to 41; of setae in the middle of the first poststernal row, 28 to 38; of setae from the posterior group, 33 to 49.

Anomaly: Two specimens with three first sternals.

MATERIAL: All paratypes. The two specimens from *Tamiasciurus* in the Rocky Mountain Laboratory; all other specimens in the U. S. National Museum. Specimens from hosts:

Marmota

Montana

Ravalli County: May 17, 1945,
4; July 30, 1945, 4.

Idaho

Camas County: June 30, 1945, 2.

Tamiasciurus

Montana

Ravalli County: Mar. 27, 1946, 2.

SEASONAL DISTRIBUTION: Brennan (1948) reported collections during the months of March, April, May, June, and July.

GEOGRAPHIC DISTRIBUTION: Brennan (1948) listed collections from Ravalli County, Mont., and Camas and Elmore Counties, Idaho (fig. 7,a).

DIAGNOSIS: *E. luteodema* is the only North American species which lacks specialized setae on the genu II, the genu III, and the tibia III.

17. *Euschöngastia marmotae*, new species

FIGURE 7,a; PLATES 7, 16

DESCRIPTION: Size: Engorged length, 430 to 660; width, 340 to 615.

Shape: Broad ovoid to broad oval.

Color: Orange.

Gnathosoma: Seta on palpal femur strong with relatively few setules on its convex curvature. Seta on palpal genu with few

setules, usually two to eight. Dorsal seta on palpal tibia with one or two rows of setules; lateral seta usually nude, two out of forty branched; ventral seta with few setules in two rows. Palpal claw strong with three prongs, median prong longest and strongest. Galeal seta usually with two setules (table 12). Base of chelicera heavy; blade smooth and curved with distinct subapical dorsal tooth and larger ventral tooth. Palpal coxa and base of chelicera punctate.

Anomaly: One specimen with four prongs on one palpal claw.

TABLE 12.—*Distribution of setules on the galeal setae of 18 specimens of E. marmotae*

Number of setules	Frequency	Number of setules	Frequency
0	1	3	6
1	4	4	1
2	19	?	5

(Question mark indicates undetermined number of setules)

Legs: Leg I with two slender genualae and a microgenuala, two tibialae and a microtibiala, a rather small spur with distal microspur, a subterminala, a parasubterminala, and a pretarsala. Leg II with a slender genuala, two slender tibialae, a rather small spur with proximal microspur, and a pretarsala. Leg III with a slender genuala. Nonspecialized leg setae with relatively few, straight setules. Punctae on coxae; fine punctae on distal segments not always visible. Claws and empodium long and strong.

Scutum: Large. Anterior margin slightly convex between anteromedian seta and posterolaterals. Lateral margins slightly convex, diverging posteriorly. Posterior margin somewhat paralleling anterior margin, convex posterior to pseudostigmata and concave between them. Posterolateral corners pointed, bearing posterolateral setae. Setae large and strong with relatively few setules, set close to margin. Pseudostigmata slightly behind a line drawn between the posterolaterals. Sensillae long, clavate, widest in distal third, free end rounded or with a heavy pointed setule; anterior surface well clothed with setules; setules few on posterior surface; pedicel distinct. A long, slight ridge anterior to each pseudostigma, beginning just anteromedial to the pseudostigma and running laterally and anteriorly, curving posteriorly near lateral margin; sometimes indistinct or absent. Punctae scattered. Usually two small pits between each posterolateral seta and the pseudostigma.

Standard data of the type specimen from Jefferson County, Pa.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
72	102	27	33	28	10	61	44	82	47 x 13

Summary of standard data from five specimens, including the type, from Jefferson County, Pa.:

AW 67-76, mean 71.2; PW 98-114, mean 106.2; AP 24-27, mean 25.6; SB 32-38, mean 35.4; ASB 28-31, mean 29.8; PSB 9-12, mean 10.6; AL 56-63, mean 58.8; AM 44-56, mean 47.8; PL 76-82, mean 80.8; S 40-47, mean 43.6. Width of head of sensilla, 13 to 15, mean 13.4.

Eyes: Two pairs; anterior pair lateral to posterolateral setae. Diameter of anterior pair in five specimens, 12 to 14, mean 13; of posterior pair, 10 to 14, mean 12.6.

Dorsal setae: Rather heavy with relatively few heavy setules. Length of humerals, 72 to 90; of setae near the middle of the first posthumeral row, 57 to 63; of setae in the posterior group, 50 to 54. Tendency for setae to occur out of line in anterior rows not so pronounced as in *E. luteodema*.

Dorsal formulae of five specimens from Jefferson County, Pa.:

2	..	14	..	11	..	2	..	10	..	8	..	6	..	2	(type)
2	..	15	..	17	..	..	13	..	8	..	7	..	1		
2	..	13	..	13	..	1	..	11	..	8	..	6	..	2	
2	..	14	..	16	..	..	12	..	9	..	6	..	3		
2	..	13	..	14	..	..	13	..	8	..	7	..	3		

Ventral setae: Setules on sternals and anterior poststernals fine, becoming heavier posteriorly. Data from five specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 40 to 50. Length of first sternals, 50 to 58; of second sternals, 42 to 50; of setae near the middle of the first poststernal row, 36 to 40; of setae in the posterior group, 47 to 56.

Anomaly: One nude second sternal on the type.

MATERIAL: Type, USNM 1995. Specimens from hosts:

Marmota m. monax

Pennsylvania

Jefferson County: Apr. 19, 1948,
USNM-type+4, DU-7, RML-2,
CEF-4, CM-2, KU-1, Afr-1,
Aus-1; June 8, 1948, DU-4,
CEF-1.

Marmota

Pennsylvania

Warren County: July 12, 1948,
DU-1.

SEASONAL DISTRIBUTION: *E. marmotae* has been collected during the spring and summer months of April, June, and July.

GEOGRAPHIC DISTRIBUTION: *E. marmotae* has been collected in northwestern Pennsylvania (fig. 7,a).

DIAGNOSIS: *E. marmotae* has the characters of the "*luteodema*" group. It is easily distinguished from *E. luteodema* by having a genuala II and a genuala III.

ECOLOGY: According to Mr. Neil D. Richmond, the *Marmota* collected on Apr. 19, 1948 was taken in an orchard. The chiggers were attached in hair follicles on the back and sides of the host.

CULTURES: A single culture (No. 61) was established with the orange colored nymphs of *E. marmotae*.

Date established: May 2, 1948.

Container: Large, wide-mouth jar, 140 mm. by 135 mm., with plaster-charcoal base. On June 23, 1948, a wide-mouth pint jar completely lined with plaster-charcoal. On Aug. 24, 1948, a special plaster-charcoal lined vial.

Medium: Natural forest soil about 20 mm. in depth. On June 23, 1948, soil. On Aug. 24, none.

Source: About 130 nymphs from larvae engorged on *Marmota m. monax* collected Apr. 19, 1948.

Food offered: Before June 23, only the organisms contained in the soil medium. After June 23, *Aedes aegypti* eggs and May fly eggs in addition to the contained soil organisms. After Aug. 24, *Aedes aegypti* eggs.

Results: Nymphs disappeared into soil. One seen on May 21. Flooded culture with water on June 23 and recovered 48 active nymphs. Transferred nymphs to new container. Nymphs were observed regularly in the new container. On June 29 May fly eggs were placed in the culture. About 10 nymphs tried to feed on the May fly eggs. At times the contracting and expanding trombiculid feeding motion of the body occurred but no other evidence of feeding was detected. On June 30 no nymphs were in sight when the container was opened; but many soon appeared. One approached a mass of May fly eggs and seemed to try to feed. Body contractions and expansions occurred; but no other evidence was detected. On Aug. 24 the culture was flooded and four living nymphs were recovered. *Onychiurus* sp. also were recovered. *Aedes* larvae soon were active in the flotation. Nymphs transferred to new container. In the special vial no feeding attempts were observed. Nymphs were last observed alive on Aug. 31. All were dead on Sept. 6, 1948.

LIFE HISTORY: From the data of Culture 61, *E. marmotae* engorged larvae can metamorphose into nymphs in 13 days. Four nymphs survived 121 days.

REMARKS: Although *E. luteodema* and *E. marmotae* are easily distinguished morphologically and their known geographic ranges are widely separated, the two species are very similar. Collections of both are scant, but there is apparently a host preference for

species of *Marmota*. The nature of these correlations is yet to be determined.

13. *Euschöngastia hamiltoni* Brennan

FIGURE 7,a; PLATES 6, 17

Euschöngastia hamiltoni Brennan, 1947, pp. 251-252, fig. 4A-D.—Fuller, 1952, pp. 182, 184.

DESCRIPTION: Size: Engorged length, 560 to 740; width, 350 to 390.

Shape: Long oval.

Color: Pale yellow (Brennan, 1947).

Gnathosoma: Seta on palpal femur long, curved, with long setules set well apart in about three alternate rows on the outer curvature. Seta on genu shorter, with long setules spaced in about two alternate rows. Dorsal seta on palpal tibia arched anteriorly with a few long setules on the convex curvature; lateral seta usually nude, one on one specimen with three small setules; ventral seta rather short with setules spaced usually in two alternate rows. Palpal claw long, curved; with five prongs, median prong longest and heaviest, two somewhat shorter, and two smaller on the convex curvature. Galeal seta with one to four setules. Cheliceral base heavy, angulate posterolaterally; blade smooth with tiny subapical dorsal tooth and larger ventral tooth. Scattered punctae on palpal coxa and cheliceral base.

Legs: Leg I with two long, slender genualae and a rather long microgenuala, two typical tibialae and a microtibiala, a long spur with a microspur set almost the length of the spur distally, a subterminala, a parasubterminala, and a pretarsala. Leg II with a long, slender genuala, two tibialae, a rather slender spur with microspur just proximal to it, and a pretarsala. Leg III with a long, slender genuala. Nonspecialized setae with relatively few setules, some straight, others curving to form an open frill. Scattered punctae on all coxae, also on all other leg segments of some specimens.

Scutum: Somewhat rectangular in general outline. Anterior margin generally concave with a slight convexity at the anterior median seta. Lateral margins slightly concave, diverge posteriorly. Posterior margin generally parallels the anterior margin, slightly convex posterolateral to the pseudostigmata and slightly concave between them. The anterolateral and the posterolateral setae are on the slightly extended corners; anteromedian set close to margin. Setae with relatively few setules. Anterolateral

and posterolateral setae long and about the same length. Pseudostigmata set on or close to a line drawn between the posterolateral setae. Pedicel of sensilla distinct, enlarging into the ovoid head; anterior surface of head well clothed with setules, posterior surface and distal end more sparsely covered. An oblique ridge extends anterolaterally from near the anteromedian edge of each pseudostigma, curving posteriorly near the lateral margin and terminating near the posterior margin about halfway between the posterolateral seta and the pseudostigma.

Summary of standard data of the five specimens studied from New York and West Virginia (S's from two specimens):

AW 60-65, mean 62.6; PW 81-87, mean 83.6; AP 26-32, mean 28.2;
SB 23-27, mean 25.2; ASB 25-29, mean 27; PSB 12-14, mean 12.8;
AL 69-83, mean 73.4; AM 32-40, mean 35.4; PL 65-73, mean 69.2;
S 25 and 27. Width of head of sensilla in two specimens, 15 and 15.

Eyes: Two pairs; anterior pair slightly anterior to posterolateral setae; posterior pair posterior to scutum. Size large, diameter of anterior eyes of five specimens, 14 to 16, mean 14.6; of posterior eyes, 13 to 14, mean 13.2.

Dorsal setae: With rather large, distinct setules; nude adjacent to body. Length of humerals, 57 to 69; of setae near the middle of the first posthumeral row, 54 to 57; of setae in the posterior group, 34 to 44.

Setal formulae for five specimens:

New York

Germantown: 2 .. 10 .. 10 9 .. 7 .. 5 .. 4

Millertown: 2 .. 10 .. 9 .. 2 .. 8 .. 6 5

West Virginia

Hardy County: 2 .. 10 .. 9 .. 1 .. 9 .. 6 .. 4

2 .. 11 .. 9 .. 2 .. 8 .. 6 .. 4 .. 2

2 .. 10 .. 10 .. 2 .. 8 .. 7 .. 6

Ventral setae: Poststernals similar in form to dorsals. Number of first sternals, 2; of second sternals, 2; of poststernals, 40 to 43. Length of first sternals, 40 to 52; of second sternals, 32 to 36; of setae near the middle of the first poststernal row, 25 to 32; of setae in the posterior group, 36 to 41.

MATERIAL: Borrowed from the Rocky Mountain Laboratory. New York specimens are paratypes. Specimens from hosts:

Myotis subulatus leibii

New York

Germantown: Mar. 17, 1946, 1.

Eptesicus f. fuscus

New York

Millertown: Feb. 12, 1947, 1.

Myotis lucifugus

West Virginia

Hardy County: Apr. 20, 1947, 3.

SEASONAL DISTRIBUTION: *E. hamiltoni* has been collected in February, March, and April.

GEOGRAPHIC DISTRIBUTION: *E. hamiltoni* has been collected from Dutchess and Putnam Counties, N. Y., and from Hardy County, W. Va. (fig. 7,a).

DIAGNOSIS: *E. hamiltoni* can be distinguished by the following combination of characters: No tibiala III, palpal claw with more than three prongs, scutum roughly rectangular, anterolateral setae and posterolateral setae long and about the same length.

REMARKS: *E. hamiltoni* has been collected only from bats in the eastern United States. Morphologically it is very distinct from the one other species, *E. pipistrelli*, reported from bats. A most unusual difference occurs in the eyes of the two species. *E. pipistrelli* has the most reduced eyes of North American *Euschöngastia*, and *E. hamiltoni* has the largest.

E. hamiltoni appears to be intermediate in character. Although it is a typical *Euschöngastia*, it cannot clearly be grouped morphologically with any other species.

The "*blarinae*" group

The "*blarinae*" group of *Euschöngastia* consists of five species. Diagnostic features include: No tibiala III; palpal claw with more than three prongs; scutum wider than long, more or less pointed at the posterolateral corners, anterolateral setae much shorter than the posterolaterals; lateral seta on palpal tibia nude; galeal seta with setules.

19. *Euschöngastia blarinae* (Ewing)

FIGURE 7,d; PLATES 5, 8, 18

Trombicula blarinae Ewing, 1931, pp. 11-12, 19, pl. 1, fig. 1.—Radford, 1942, pp. 57, 59, fig. 3.—Michener, 1946, p. 431.—Sig Thor and Willmann, 1947, pp. 259, 271.

Neoschöngastia blarinae, Ewing, 1946c, pp. 21, 22.

Euschöngastia blarinae, Fuller, 1948, p. 103; 1952, pp. 182, 183.

DESCRIPTION: Size: Length, 205 to 600; width, 155 to 580.

Shape: Unengorged, broad ovoid, rounded posteriorly; engorged, ovoid to oval.

Color: Opaque white with red eyes.

Gnathosoma: Short and broad. Seta on palpal coxa with long setules. Seta on palpal femur rather heavy with long, spaced setules. Genual seta with about two short rows of long setules. Dorsal seta on palpal tibia with two alternate rows of setules; lateral seta nude, slender; ventral seta with a few long, alter-

nately arranged setules. Palpal claw varies from slightly curved to almost straight; rather slender; with five prongs, three of about equal length, the median prong somewhat heavier, and two shorter on the outer surface. Galeal seta usually with one to three setules (table 13). Base of chelicera heavy, blade smooth, subapical dorsal tooth greatly reduced, usually not discernible; ventral tooth distinct. Punctae on palpal coxa, none on chelicer base.

TABLE 13.—*Distribution of setules on the galeal setae of 20 specimens of Euschöngastia blarinae*

Number of setules	Frequency
1	17
2	16
3	4
?	3

(Question mark indicates undetermined number of setules)

Legs: Leg I with two slender genualae and a microgenuala, two tibialae, the more proximal the longer, and a microgenuala, a middorsal spur with microspur about half the length of the spur distal, a subterminala, a small parasubterminala, and a pretarsala. Leg II with a slender genuala, two tibialae, a spur with microspur proximal and anterior, and a pretarsala. Leg III with a slender genuala. Most nonspecialized setae beyond trochanters with fine, curved setules; a few on dorsal surfaces with straight setules. Empodium slightly longer than claws. Leg segments stout; legs without noticeable taper. Coxae and distal leg segments punctate.

Anomalies: Two specimens with two setae on one coxa III. One specimen with one parasubterminala lacking. One specimen with three tibialae I on one leg.

Scutum: Slightly more than twice as wide as long. Anterior margin concave between anteromedian seta and anterolaterals. Lateral margins slightly concave, diverging posteriorly. Posterior margin approximately parallel to the anterior margin, convex posterolateral to the pseudostigmata and slightly concave between them. The four extended corners bear the anterolateral setae and the posterolateral setae. The anteromedian seta set near the margin on an anterior convexity. Posterolateral setae longest. All setae heavy with very large setules spaced on the shafts, the posterolaterals particularly appearing quite spiny. Pseudostigmata posterior to a line drawn between the posterolaterals. Sensillae long clavate, head enlarging evenly from the base of the pedicel for three-fourths its length and rounding off distally;

covered with large setules which tend to stand out in a frill on the basal half. Sensillae usually broken off. Anterior to each pseudostigma is a wide inverted U-shaped ridge, the inner leg terminating medial to the pseudostigma, the outer leg extending to the posterior margin; often obscured. Surface punctate. Usually a pair of pits larger than punctae near the ridge medial to each posterolateral seta.

Summary of standard data of 21 specimens of *E. blarinae* from over its range (AM's from 20 specimens, S's from 7) :

AW 54-63, mean 57.5; PW 74-93, mean 80.2; AP 14-21, mean 17.7; SB 26-36, mean 29.6; ASB 21-28, mean 24.1; PSB 7-11, mean 8.4; AL 32-47, mean 40.4; AM 35-45, mean 40.6; PL 63-82, mean 70.2; S 35-39, mean 37.7. Width of head of sensilla of seven specimens, 9-11, mean 10.

Eyes: Two pairs; anterior pair lateral to posterolateral setae. Diameter of anterior eyes of eight specimens, 7 to 12, mean 9.4; of posterior eyes, 7 to 10, mean 8.5.

Dorsal setae: Similar to the scutal setae, with large setules spaced over the shaft; spiny appearance. In unengorged specimens humeral setae lie in first "posthumeral" row. Length of humerals of 16 specimens, 57 to 67; of setae near the middle of the first posthumeral row, 44 to 60; of setae in the posterior group, 35 to 47.

Dorsal setal formulae for 20 specimens:

North Carolina

Durham and Orange	2	..	11	..	8	..	..	10	..	8	..	6	..	2
Counties:	2	..	10	..	12	..	..	10	..	6	..	6	..	
	2	..	10	..	8	..	..	11	..	8	..	4	..	
	2	..	10	..	12	..	..	10	..	6	..	6	..	
	2	..	10	..	9	..	..	11	..	6	..	6	..	

Virginia

Giles County:	2	..	10	..	11	..	..	10	..	6	..	4	..	
	2	..	10	..	11	..	..	10	..	7	..	7	..	

District of Columbia

Rock Creek Park:	2	..	10	..	12	..	..	11	..	6	..	6	..	
	2	..	10	..	11	..	..	8	..	5	..	6	..	
	2	..	10	..	?	..	2	..	8	..	5	..	4	

Pennsylvania

Jefferson County:	2	..	10	..	13	..	..	10	..	6	..	6	..	
	2	..	10	..	10	..	..	11	..	6	..	6	..	2
Venango County:	2	..	10	..	12	..	..	12	..	6	..	6	..	
	2	..	10	..	9	..	2	..	10	..	6	..	6	..
	2	..	10	..	12	..	..	11	..	6	..	6	..	
Warren County:	2	..	10	..	9	..	..	10	..	8	..	6	..	
	2	..	10	..	12	..	..	11	..	6	..	6	..	
	2	..	10	..	10	..	..	12	..	6	..	6	..	1

Cameron County:	2 .. 9 .. 11 9 .. 6 .. 6
Erie County:	2 .. 10 .. 8 10 .. 8 .. 7 .. 2

Ventral setae: Poststernals smaller than dorsals but of the same general character with setules in proportion; increasing in size posteriorly. Data from 16 specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 38 to 47. Length of first sternals, 44 to 60; of second sternals, 38 to 51; of setae near the middle of the first poststernal row, 28 to 37; of setae in the posterior group, 35 to 48.

MATERIAL: Type (No. 1018) and paratypes in the U. S. National Museum. All other material in the Duke University collections. Specimens from hosts and unattached:

<i>Blarina brevicauda</i>	<i>Sorex f. fumeus</i>
District of Columbia	Pennsylvania
Rock Creek Park, Sept. 18, 1929,	Venango County: May 1947, 1.
4 (paratypes); Sept. 20, 1929,	<i>Sorex l. longirostris</i>
3 (paratypes).	Virginia
Pennsylvania	Giles County: Aug. 1947, 20.
Monroe County: May 1945, 1.	Soil, mammal runway
Warren County: Sept. 1947, 19;	North Carolina
Oct. 1947, 2.	Durham County: Feb. 1948, 1.
Erie County: Nov. 1947, 12.	<i>Sorex c. cinereus</i>
North Carolina	Pennsylvania
Durham County: Dec. 1947, 1.	Jefferson County: Apr. 1948, 1.
Orange County: Jan. 1948, 1;	Leaves from cavity of decayed-out
July 1948, 7; Oct. 1948, 2;	root system
Dec. 1949, 10.	North Carolina
<i>Peromyscus leucopus</i>	Orange County: Dec. 1948, 2.
District of Columbia	Forest Soil
Rock Creek Park, Sept. 20, 1929,	North Carolina
1 (type).	Orange County: Dec. 1948, 1
<i>Blarina b. brevicauda</i>	Decayed root system
Pennsylvania	North Carolina
Venango County: Apr. 1947, 23;	Orange County: Mar. 1949, 1.
May 1947, 13.	<i>Blarina</i> sp.
Warren County: Sept. 1947, 12.	Pennsylvania
Venango County: Apr. 1948, 25.	Cameron County: Sept. 1949, 5.
Jefferson County: Apr. 1948, 3.	

GEOGRAPHIC DISTRIBUTION: *E. blarinae* has been collected in Durham and Orange Counties, N. C., Giles County, Va., the District of Columbia, and northwestern Pennsylvania (fig. 7,d).

SEASONAL DISTRIBUTION: Over its range *E. blarinae* has been collected from its hosts in every month of the year except June. In Orange County, N. C., it has been collected in almost equal numbers from single hosts in July and December. The record of

collections from shrews in the Duke Forest area shows the single *Blarina brevicauda* trapped in January was infested with *E. blarinae*; one *B. brevicauda* trapped in March and two trapped in April were not infested; one of two *B. brevicauda* trapped in July was infested; the single *B. brevicauda* trapped in September was not infested; the one trapped in October was infested; and two out of three trapped in December were infested. A summary of these collections shows one positive host out of five hosts collected from April to September and four positive hosts out of six hosts collected from October to March. However, at this time collections are not adequate for any reasonable picture of seasonal distribution for *E. blarinae*.

DIAGNOSIS: *E. blarinae* can be distinguished from other species in the "*blarinae*" group by the following combination of characters: Scutum and free leg segments punctate, cheliceral base without punctae, and galeal setae branched. The heavy scutal and dorsal setae clothed with uniformly large setules will distinguish the species in good preparations. When the distinctive sensillae are present, they alone will serve to differentiate *E. blarinae*.

ECOLOGY: In Pennsylvania, *E. blarinae* was collected from shrews which were trapped in a variety of situations. According to Mr. Neil Richmond, hosts were taken among weeds and briars along a railroad. The ground was cool and wet. The weather was hot in late summer. They were taken in a narrow, rocky ravine where hemlock and yellow birch were the dominant trees. The site was cool and well watered. Some nights were below freezing in late spring. Hosts infested with the chiggers were trapped in hardwoods on a dry ridge in September. They were taken, also, among black and yellow birch, hemlock, and red maple on a round, well-watered knoll in May.

In Duke Forest most host shrews were trapped in the oak-hickory upland hardwoods communities. One of the December collections and the January collection were made on well-drained ridge tops at a small decayed-out stump and at a pile of stones. The other December collection was at the base of a small shrub on a gently sloping hillside. The weather was cold or freezing. The July collection was from a level area between two slopes. The October collection was made from a narrow bottomland along a permanent stream. River birch, yellow poplar, and sweet gum were the dominant trees.

The one common factor in all collections was shrews. *E. blarinae* was found on no other hosts in collections from the Duke

Forest area and in the collections shipped in by other workers. The chiggers were found crawling on the fur or imbedded in craters in the skin of *Blarina* on the posterior portion of the venter and on the rump. Other collectors usually reported the same distribution on this host. Mr. Richmond reported collecting them from folds in the pinna of *Sorex c. cinereus*.

Unengorged, unattached *E. blarinae* have been collected from forest soil, from forest soil surrounding a mammal runway, and from materials in decayed-out root systems. This distribution is consistent with its apparent host preference.

CULTURES: Five cultures containing *E. blarinae* were established. One was started with engorged larvae, the others with nymphs. In one culture nymphs were identified from their cast larval skins. *Sinella curviseta* was established in this culture and developed well. No stage of *E. blarinae* beyond nymph was obtained.

LIFE HISTORY: From collection and culture records it was determined that nymphs could develop from engorged larvae in 16 days or less. One nymph was observed alive 48 days after its culture had been established.

REMARKS: With a single exception all known collections of *Euschöngastia blarinae* have been from shrews. The single exception is that of the type specimen which is recorded from the deer mouse, *Peromyscus leucopus*. This seeming anomaly in distribution on hosts focuses attention on the type specimen. The attention becomes critical when it is considered that other species of chiggers which can be confused with *E. blarinae* usually occur on *P. leucopus*. Further, the hosts from which *E. blarinae* was originally described were reported as *Blarina brevicauda* and *Peromyscus leucopus*. The type host was given as *Blarina brevicauda*. However, the label on the type slide (USNM 1018) bears the host name *Peromyscus leucopus*. There is the possibility of confusion in labeling.

The one specimen, the holotype, on the type slide has been carefully examined. The sensillae are missing. Various other diagnostic characters are obscured. It does resemble the paratypes listed from shrews. It also bears a certain resemblance to *E. setosa*, which is found on *Peromyscus*. At the present time it cannot be positively identified. The paratypes, like the type, have the sensillae missing and various other diagnostic characters are obscured. Weak evidence can be obtained from the paratypes indicating conspecificity with the material described here from

the Duke University collections. The doubt cast on the type specimen by its host record has not been eliminated by its morphology. On the other hand there is no proof that it is not conspecific with the paratypes and with the new material described here. Although some question may remain concerning the type specimen or its host record, there is no basis for disturbing the nomenclature and the name *Euschöngastia blarinae* is retained for the species redescribed here.

20. *Euschöngastia carolinensis*, new species

FIGURE 7,c; PLATES 2, 5, 7, 19

DESCRIPTION: Size: Length, 230 to 550; width, 155 to 460.

Shape: Unengorged in life, broad oval; all preserved specimens, broad oval.

Color: Opaque white to cream, with red eyespots.

Gnathosoma: Seta on palpal coxa with a fringe of setules on the convex curvature. Seta on palpal femur strong with strong setules. Seta on palpal genu with setules closely arranged in two alternate rows. Dorsal seta on palpal tibia with few setules; lateral seta slender and nude; ventral seta with setules closely arranged in two alternate rows. Palpal claw stout, without taper, terminating in six or seven closely grouped prongs, median prong slightly the longest. Galeal seta with about two to six setules (table 14). Cheliceral base heavy, faintly punctate; blade smooth, curved, with tiny subapical dorsal tooth and a larger ventral tooth. Conspicuous punctae on palpal coxa.

TABLE 14.—*Distribution of setules on the galeal setae of ten specimens of Euschöngastia carolinensis*

Number of setules	Frequency
2	1
3	6
4	9
5	2
6	1
?	1

(Question mark indicates undetermined number of setules)

Legs: Leg I with two rather long genualae, a microgenuala, two tibialae with a microtibiala, a spur of moderate size with a microspur about two-thirds the length of the spur distal and posterior to it, a stout subterminala, a rather small parasubterminala, and a pretarsala. Leg II with a rather long genuala, two tibialae, a moderate spur with microspur slightly proximal and

anterior to it, and a pretarsala. Leg III with a slender genuala. Nonspecialized setae distal to trochanter of leg I rather slender with a frill of numerous, short, curved setules; setae on the dorsal surface of tarsus with few, straight setules. Both sorts of non-specialized setae beyond trochanter of leg II; those dorsal and anterior tending to have fewer, straight setules; those ventral and posterior tending to have numerous, short, curved setules. Most feathered setae on leg III with short, curved setules. Empodium more slender than claws but about the same length. All coxae punctate; all distal segments may have few punctae, usually present on segments 4, 5, and 6. Segments stout; legs without noticeable taper.

Scutum: The form in general similar to that of *E. blarinae*, with similar ridges, but with a slightly less regular outline. Punctae usually not distinguishable; sometimes found within areas bounded by the ridges. Usually two pits near the posterolateral terminus of each ridge. Scutal setae with heavy shafts well covered with slender, rather long setules. Sensillae clavate, heads enlarging more abruptly than in *E. blarinae*, largest about two-thirds the length from the base; usually somewhat pointed on the distal end; closely covered with moderate setules on the anterior surface, sparsely covered on the posterior surface.

Standard data for five specimens from Orange County, N. C.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
60	81	19	27	22	8	50	36	67	35 x 12 (type)
63	92	23	32	27	8	51	25	70	
60	78	17	26	22	8	45	35	69	32
61	79	18	29	22	7	52		66	33 x 12
58	76	19	25	22	8	50	35	66	32 x 11

Eyes: Two pairs; rather small. Anterior pair just lateral to the posterolateral setae. Data from five specimens: Diameter of anterior eyes, 7 to 9, mean 8.4; of posterior eyes, 6 to 9, mean 7.4.

Dorsal setae: Two distinct forms. Setae in the first two post-humeral rows tend to be nude adjacent to body; on lateral edges adjacent to body are two alternate rows of larger setules; numerous, more slender setules cover the lateral and opposite surfaces. Setae in the three posterior rows flattened, lanceolate, leaflike, with short, sharp setules on lateral edges and the surface away from the body. The flattened setae sometimes occur at the ends of the second posthumeral row. Data from five specimens: Length of humerals, 59 to 63; of setae near the middle of the first post-humeral row, 54 to 56; of setae in the posterior row, 47 to 57.

Dorsal formulae for five specimens from Orange County, N. C.:

2	..	10	..	10	..	12	..	8	..	4	(type)
2	..	10	..	12	..	12	..	7	..	6	
2	..	10	..	10	..	12	..	8	..	4	
2	..	10	..	10	..	11	..	8	..	4	
2	..	10	..	10	..	12	..	6	..	6	

Ventral setae: Poststernals with numerous setules of moderate length. The most posterior row of setae about the level of the anus; continuous with the most posterior row of dorsals; usually with some flattened setae. Data from five specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 33 to 40. Length of first sternals, 48 to 54; of second sternals, 38 to 41; of setae near the middle of the first poststernal row, 31 to 37; of posterior setae, 41 to 58.

MATERIAL: Type, USNM 1996. Specimens from hosts and unattached; all in North Carolina:

Pitymys p. pinetorum

Orange County: May 9, 1948,
CEF-1.

Cavities of decayed root systems and
under decaying stumps

Orange County: Mar. 20, 1949,
KU-1; Jan. 22, 1950, CEF-1.

Peromyscus leucopus

Orange County: July 3, 1949,
CEF-1.

Surface soil

Orange County: Jan. 1, 1950,
USNM-Type+2, DU-3, RML-1;
Jan. 7, 1950, CM-1.

SEASONAL DISTRIBUTION: Collections of *E. carolinensis* have been made in winter, spring, and summer. Records are too few to determine if seasonal population peaks occur.

GEOGRAPHIC DISTRIBUTION: *E. carolinensis* has been collected only in Orange County, N. C. (fig. 7,c).

DIAGNOSIS: *E. carolinensis* can be distinguished from the other members of the "*blarinae*" group by the flattened, leaflike setae in the three posterior dorsal rows. It is most like *E. ohioensis*, but there is only one row of flattened dorsal setae in the latter species.

ECOLOGY: Both host records for *E. carolinensis* are from mice trapped in the New Hope Creek Division of Duke Forest. The *Pitymys* was taken in a north-facing ravine in Compartment 6. Beech was represented among the dominant trees. The *Peromyscus* was taken among the second growth of a cut-over ridge top in Compartment 11. The unattached chiggers were collected from sites in upland hardwoods in the Durham Division of the forest. One was from an east-facing slope, one from a west-facing slope and one from the ridge top.

Only one chigger was removed directly from a host. It was found free on the fur near the anus of *Pitymys*.

REMARKS: The type specimen of *E. carolinensis* is an unengorged, unattached specimen collected from soil (pl. 2).

21. *Euschöngastia ohioensis*, new species

FIGURE 7,c

DESCRIPTION: Size: Length, 240 to 675; width, 160 to 705.

Shape: Oval to broad oval to almost square; specimens flattened on sides sometimes wider than long.

Color: Cream to opaque white.

Gnathosoma: Generally similar to that of *E. carolinensis*. Genual seta with fewer setules. Palpal claw usually slightly curved; with five to seven prongs, three longer with the median of these longest; form similar to that of *E. setosa*. Galeal seta usually with two to five setules (table 15).

TABLE 15.—Distribution of setules on the galeal setae of ten specimens of *Euschöngastia ohioensis*

Number of setules	Frequency	Number of setules	Frequency
2	1	5	1
3	7	?	1
4	10		

(Question mark indicates undetermined number of setules)

Legs: Generally as in *E. carolinensis*.

Scutum: Generally similar to that of *E. carolinensis*; larger. Punctae usually visible. Anterolateral and anteromedian setae similar to those of *E. carolinensis*; posterolateral setae with two alternate rows of heavy setules spaced along lateral edges of the side adjacent to body as the seta projects posteriorly; the portions of the setae opposite to the body closely covered with small setules.

Standard data of the type specimen from Clermont County, Ohio:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
66	97	22	35	25	7	54	32	65	35 x 11

Summary of standard data of six specimens, including the type, from over its range (AM's and S's from five specimens):

AW 66-78, mean 72.2; PW 90-113, mean 104.2; Ap 21-26, mean 22.8; SB 32-44, mean 37.2; ASB 25-31, mean 27.5; PSB 7-10, mean 8.2; AL 44-58, mean 53; AM 32-32, mean 32; PL 60-66, mean 63.2; S 35-36, mean 35.4. Width of head of sensilla in five specimens, 11 to 13, mean 11.8.

Eyes: Two pairs, often difficult or impossible to find in this material. Data from two specimens: Diameter of anterior eyes, 7 to 10, mean 8.5; of posterior eyes, 6 to 7, mean 6.5.

Dorsal setae: Two distinct forms. Setae in the four anterior posthumeral rows somewhat similar to the anterior dorsal setae of *E. carolinensis*, but with a very striking disproportion in size between the two rows of heavy setules and the smaller opposite setules. The flattened, leaflike setae confined mostly to the last posthumeral row. Occasionally a few like the anterior dorsals in the final row, or a few flattened setae laterally in the fourth posthumeral row. Length of humerals in six specimens, 54 to 63; of setae near the middle of the first posthumeral row, 48 to 55; of setae in the posterior row, 48 to 54.

Dorsal setal formulae for six specimens:

Ohio

Clermont County: 2 .. 12 .. 14 .. 14 .. 9 .. 6

Pennsylvania

Indiana County: 2 .. 12 .. 12 .. 13 .. 8 .. 6

Warren County: 2 .. 11 .. 12 .. 12 .. 7 .. 4

Cameron County: 2 .. 11 .. 12 .. 10 .. 7 .. 4

Lycoming County: 2 .. 12 .. 15 .. 14 .. 8 .. 4

New Jersey

Mount Holly: 2 .. 13 .. 15 .. 15 .. 8 .. 6

Ventral setae: Poststernals generally similar to those of *E. carolinensis*. Data from six specimens: Length of first sternals, 44 to 57; of second sternals, 44 to 48; of setae near the middle of the first poststernal row, 32 to 42; of posterior setae, 40 to 57.

MATERIAL: Type, USNM 1997. Specimens from hosts:

Pitymys pinctorum scaiopsoides

Pennsylvania

Warren County: Sept. 8, 1947,
DU-8, Afr-1, Aus-1.

New Jersey

Mount Holly: Oct. 30, 1948,
USNM-1, DU-4.

Synaptomys cooperi saturatus

Ohio

Clermont County: Mar. 5, 1948,
DU-1; Mar. 20, 1948, CEF-1;
Feb. 25, 1949, USNM-type+2;
Feb. 27, 1949, RML-2.

Pitymys pinctorum auricularis

Ohio

Hamilton County: Mar. 5, 1948,
DU-1.

Clethrionomys g. gapperi

Pennsylvania

Lycoming County: Mar. 30, 1949,
USNM-1, DU-2, CEF-1, CM-2.

Synaptomys cooperi stenei

Pennsylvania

Indiana County: Apr. 22, 1949,
KU-1.

Pitymys sp.

Pennsylvania

Cameron County: Sept. 1, 1949,
DU-4, CEF-4.

SEASONAL DISTRIBUTION: Known collections of *E. ohioensis* have been made in fall, winter, and spring. Information is not adequate to determine variations, if any, in seasonal occurrence.

GEOGRAPHIC DISTRIBUTION: *E. ohioensis* has a northern distribution. Collections have been made from southwestern Ohio, through north-central Pennsylvania, to south-central New Jersey (fig. 7,c).

DIAGNOSIS: *E. ohioensis* is most similar to *E. carolinensis*. It can be distinguished from that species by the fewer leaflike setae confined mostly to the last posterior row, by the difference in the anterior dorsal setae, and by the greater number of dorsal setae.

ECOLOGY: The Warren County, Pa., collections were reported to have been made near a poorly drained ridge top among red maple, black oak, and cucumber tree. The Hamilton County, Ohio, locality was reported to be a hilltop grown up in black locust (6 to 30 feet), elm, and ailanthus; timothy and bluegrass, blackberry and dewberry covered the ground. Two localities were reported from Clermont County, Ohio. One was a steep slope with southern exposure, covered with timothy, bluegrass, blackberry, goldenrod, and sweet clover, and small elms and locust. The second locality was rolling farm land, idle for a couple of years, with locust seedlings or shrubs in bluegrass and blackberry.

Collectors generally reported *E. ohioensis* chiggers to be located around the anal opening of the hosts. They were also reported partially imbedded in the skin over most of the abdomen, the back, and the front legs.

REMARKS: No drawings were made for *E. ohioensis*. In general, the set of drawings for *E. carolinensis* will serve for *E. ohioensis*. However, the palpal claw more closely resembles that of *E. setosa*. The scutum is larger and punctate. It is possible the generally larger size of the scutum is more apparent than real. The larger scutal measurements came from well engorged specimens. The specimen from Lycoming County, Pa., was unengorged, and its measurements are close to those of *E. carolinensis*, only one of which was at all engorged.

Euschöngastia carolinensis and *Euschöngastia ohioensis* are morphologically and geographically distinct; but they share obvious morphological similarities. There is some evidence that they have similar host preferences. One of two collections from hosts for *E. carolinensis* was from *Pitymys*. Four of ten collections from hosts for *E. ohioensis* were from *Pitymys*. Possibly they attach to similar areas on hosts. From this evidence there is a possibility the two are subspecies. Further collections are

required to determine the exact relationship between *E. carolinensis* and *E. ohioensis*.

22. *Euschöngastia crateris*, new species

FIGURE 7,c; PLATES 5, 8, 19

DESCRIPTION: Size: Length, 275 to 800; width, 195 to 800.

Shape: Ovoid; broad oval; almost square.

Color: Yellowish, when dissicated.

Gnathosoma: Seta on palpal femur large and strong with numerous long, slender setules. Seta on palpal genu smaller, with many long, slender setules. Dorsal seta on palpal tibia slender with a few slender setules; lateral seta usually nude, occasionally with one or two small setules; ventral seta with long slender setules. Palpal claw with four or five prongs, three longer with the median prong longest and one or two shorter on the outer curvature. Long spur on palpal tarsus. Galeal seta heavy, curved, with rather long curved setules arising on opposite edges. Chelicer base heavy; blade with a rather large dorsal tooth and a large ventral tooth. Punctae on palpal coxa and chelicer base.

Legs: Leg I with two slender genualae and a microgenuala, two tibialae and a microtibiala, a spur of moderate size with a microspur about half the length of the spur distal and posterior, a slender subterminala and a small parasubterminala, and a pretarsala. Leg II with a slender genuala, two tibialae, a moderate spur with a microspur proximal or anterior to it, and a pretarsala. Leg III with a genuala. Nonspecialized setae similar in form and distribution to those of *E. carolinensis*. Empodium slightly longer than claws. Leg segments strong; legs without noticeable taper. All segments with punctae.

Anomalies: One specimen with three genualae I. One specimen with a tibiala III.

Scutum: General form much like that of *E. blarinae*. Punctae scattered. Pits near the posterolateral ends of the ridges usually distinct. Scutal setae with heavy shafts closely covered with long, slender setules. Sensillae broad clavate; heads frequently somewhat pyriform, clearly distinct from pedicels.

Standard data of the type specimen from Blair County, Pa.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
65	85	17	28	27	11	38	41	63	32 x 16

Summary of standard data of seven specimens, including the type, from over the range (AP's from six specimens, ASB's from five, S's from four):

AW 65-99, mean 78.9; PW 85-121, mean 101.7; AP 17-21, mean 19; SB 28-47, mean 36.4; ASB 25-37, mean 30.6; PSB 9-11, mean 10.1; AL 32-41, mean 37.3; AM 35-42, mean 38.4; PL 57-66, mean 60.6; S 32-38, mean 35.3. Width of sensilla of four specimens, 14 to 16, mean 15.

Eyes: Two pairs; anteriors lateral to posterolateral setae. No ocular plate, although there is some appearance of one in unengorged specimens. Measurements from five specimens: Diameter of anterior eyes, 11 to 13, mean 12.2; of posterior eyes, 8 to 11, mean 9.8.

Dorsal setae: Similar in form to the anterior dorsal setae of *E. ohioensis* but with somewhat less disproportion in size of the two kinds of setules. A strong tendency for extra setae in the rows. Measurements for eight specimens: Length of humerals, 57 to 63; of setae near the middle of the first posthumeral row, 51 to 61; of posterior setae, 38 to 46.

Dorsal formulae for seven specimens from Pennsylvania:

Blair County:	2 .. 16 .. 2 .. 14 .. 2 .. 15 .. 11 .. 9 .. 4 .. 2 (type)
	2 .. 16 .. 2 .. 20 .. 2 .. 16 .. 9 .. 7 .. 4
Bradford County:	2 .. 14 18 15 .. 10 .. 8 .. 8
Venango County:	2 .. 18 14 16 .. 10 .. 9 .. 5
	2 .. 16 16 14 .. 10 .. 9 .. 6
	2 .. 15 17 13 .. 11 .. 9 .. 6 .. 2
Mercer County:	2 .. 18 16 .. 2 .. 16 .. 9 .. 10 .. 7 .. 2

Ventral setae: Poststernals with numerous setules. Data from eight specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 54 to 68. Length of first sternals, 47 to 55; of second sternals, 39 to 50; of setae near the middle of the first poststernal row, 32 to 35; of setae in the posterior group, 44 to 49.

MATERIAL: Type, USNM 1998. Specimens from hosts, all from Pennsylvania:

<i>Clethrionomys gapperi</i>	Bradford County: Oct. 30, 1949, DU-1, RML-2.
Wayne County: July 9, 1945, KU-1.	
<i>Clethrionomys gapperi paludicola</i>	<i>Peromyscus maniculatus</i>
Venango County: Apr. 18, 1947, CM-1.	Venango County: Jan. 23, 1948, DU-1.
<i>Peromyscus leucopus noveboracensis</i>	<i>Peromyscus leucopus</i>
Mercer County: July 11, 1947, DU-1.	Blair County: June 26 or 27, 1949, USNM-type+2, DU-3, CEF-2, Aus-1, Afr-1.
Blair County: June 8, 1949, DU-1.	<i>Clethrionomys</i> sp.
<i>Peromyscus</i> sp.	Bradford County: Nov. 11, 1949, CEF-1; Nov. 13, 1949, CEF-1.
Venango County: Jan. 20, 1948, USNM-1, CM-1.	

SEASONAL DISTRIBUTION: *E. crateris* has been collected in all seasons.

GEOGRAPHIC DISTRIBUTION: *E. crateris* has been collected in Pennsylvania from the northwestern, the central, and the north-eastern parts of the State (fig. 7,c).

DIAGNOSIS: *E. crateris* can be distinguished from the other members of the "*blarinae*" group by the shape of its galeal setae, by the long spur on the palpal tarsus, and by the large number of dorsal setae.

ECOLOGY: Concerning the collection of June 26 or 27, 1949, Mr. C. L. Gifford noted: "These were taken on hot, dry cliffs of limestone and dolomite. A number of *Peromyscus* were taken there and they were almost 100% infested with that type of chigger." Unpreserved ears of this collection were received in the laboratory. The ears and the chiggers were dessicated. The chiggers were found in pits, particularly along the edge of the pinna.

REMARKS: *E. crateris* has been named for the pits or craters in which it was found on the ears of *Peromyscus*.

23. *Euschöngastia setosa* (Ewing)

FIGURE 8,a; PLATES 8, 18

Trombicula setosa Ewing, 1937, pp. 170-171.—Radford, 1942, p. 60.—

Michener, 1946, p. 432.—Sig Thor and Willmann, 1947, pp. 258, 273.

Euschöngastia setosa, Fuller, 1948, pp. 103, 104; 1952, p. 184.

DESCRIPTION: Size: Length, 205 to 635; width, 150 to 590.

Shape: Unattached in life, ovoid, idiosoma rounded. Preserved, broad ovoid to broad oval.

Color: Yellowish with red eyes.

Gnathosoma: Seta on palpal femur well covered with setules on outer curvature. Seta on palpal genu with a few long setules, often in two rows. Dorsal seta on palpal tibia with a few alternate setules; lateral seta nude; ventral seta with a few slender setules on the dorsal half of the shaft. Palpal claw curved, with five to seven prongs. Galeal seta with about two to six setules; form variable, branched, pectinate, or with setules arising from opposite sides of the shaft; an occasional seta resembling those of *E. crateris*. Cheliceral base angulate laterally; blade with a very tiny dorsal tooth and a small ventral tooth. Punctae on palpal coxa; tiny punctae on cheliceral base, not always discernible.

Legs: Leg I with two slender genualae and a microgenuala, two tibialae and a microtibiala, a short spur on the proximal half of the tarsus with a microspur about two-thirds the length of the spur distal and slightly posterior, a subterminala, a parasubterminala, and a pretarsala. Leg II with a genuala, two tibialae, a middorsal spur of moderate length with a microspur proximal

or anterior to it, and a pretarsala. Leg III with a genuala. Non-specialized setae beyond trochanter of leg I mostly with numerous, fine, short, curving setules; those on dorsal surface of the tarsus with fewer, straight setules. Nonspecialized setae of leg II with numerous, curved setules on the posterior and ventral surfaces and fewer, straighter setules on the anterior and dorsal surfaces. Most nonspecialized setae on leg III with few, straight setules; those on the dorsal surface generally with curved setules. Empodium slender, slightly longer than claws. All coxae with small punctae. Punctae apparently lacking on distal leg segments usually; but a few specimens with very fine punctae on clear, flattened segments.

Scutum: Generally similar in form to that of *E. blarinae*, with a tendency to be wider in engorged specimens. Ridges frequently obscured. Two pits usually present near the posterolateral end of each ridge. Without apparent punctae. Setae similar to those of *E. blarinae*, but less heavy and with less heavy setules. Sensillae clavate; pedicel long and slender; head ovoid, well covered with setules on the anterior surface, sparsely covered on the posterior surface.

Standard data of the cotype from Okefenokee Swamp, Ga.:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
65	95	19	30	23	8	—	—	60	—

Summary of standard data of eight specimens, including the cotype, from over the range (AL's from seven specimens, AM's from five, S's from three):

AW 60–77, mean 64.5; PW 80–112, mean 90.5; AP 16–20, mean 18.4; SB 25–42, mean 30.4; ASB 19–26, mean 23.3; PSB 7–10, mean 7.9; AL 29–38, mean 33.4; AM 32–37, mean 34.6; PL 56–65, mean 61.1; S 32–26, mean 34.3. Width of head of sensilla in three specimens, 14, 16, and 17.

Eyes: Two pairs; anterior pair lateral to posterolateral setae. Data from four specimens: Diameter of anterior eyes, 11 to 14, mean 12.8; of posterior eyes, 9 to 13, mean 11.3.

Dorsal setae: General form similar to that of *E. blarinae* but with setules less heavy. Length of humerals of eight specimens, 50 to 63; of setae near the middle of the first posthumeral row, 46 to 57; of setae in the posterior group, 35 to 42.

Dorsal formulae of eight specimens:

Georgia

Okefenokee Swamp: 2 .. 10 .. 10 .. 2 .. 9 .. 2 .. 6 .. 6 (cotype)

North Carolina

Orange County: 2 .. 11 .. 10 .. 2 .. 11 6 .. 6

2 .. 10 .. 10 10 6 .. 3

Durham County:	2 .. 10 .. 10 .. 2 .. 11 .. 2 .. 5 .. 4
Pennsylvania	
Somerset County:	2 .. 10 .. 8 .. 2 .. 10 7 .. 4
Bradford County:	2 .. 10 .. 10 .. 2 .. 10 6 .. 6
	2 .. 10 .. 11 12 8 .. 6
	2 .. 10 .. 10 .. 2 .. 10 6 .. 6

Ventral setae: Poststernals anterior to anus generally with fine setules; posterior to anus similar to dorsals. Data from eight specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 34 to 41. Length of first sternals, 38 to 50; of second sternals, 36 to 44; of setae near the middle of the first poststernal row, 32 to 36; of posterior setae, 36 to 38.

MATERIAL: Cotype, USNM 1256. All other specimens in the Duke University collections. Specimens from hosts and unattached:

Peromyscus g. gossypinus

Georgia

Okefenokee Swamp: Dec. 2, 1934,
1 (cotype).

Clethrionomys gapperi paludicola

Pennsylvania

Venango County: May 1, 1947, 1.

Napeozapus insignis

Pennsylvania

Venango County: May 4, 1947, 2.

Peromyscus leucopus noveboracensis

Beaver County: May 20, 1947, 1.

Clethrionomys sp.

Pennsylvania

Somerset County: Sept. 3, 1947, 1.

Bradford County: Nov. 10, 1949,

2; Nov. 11, 1949, 1; Nov. 13,

1949, 1.

Peromyscus leucopus

North Carolina

Orange County: Dec. 7, 1947, 2;

Dec. 28, 1947, 2; Jan. 1, 1948,

1; Jan. 9, 1949, 1; Jan. 23,

1949, 3; Jan. 30, 1949, 1; May

1, 1949, 1.

Durham County: Feb. 8, 1948, 1;

Dec. 5, 1948, 1.

Sylvilagus floridanus mallurus

North Carolina

Orange County: Dec. 27, 1949, 4.

Under old stump

North Carolina

Orange County: Jan. 22, 1950, 1.

SEASONAL DISTRIBUTION: *E. setosa* has been collected in fall, winter, and spring.

GEOGRAPHIC DISTRIBUTION: *E. setosa* has been collected in localities from the Okefenokee Swamp in Georgia, through North Carolina, to northern Pennsylvania (fig. 8,a).

DIAGNOSIS: *E. setosa* can be distinguished from other members of the "*blarinae*" group by the following combination of characters: No leaflike setae on the posterior of the body, scutum and distal leg segments without apparent punctae, head of sensilla ovoid.

ECOLOGY: *E. setosa* usually was taken in small numbers from *P. leucopus* in association with *E. peromysci*. The one collection

of an unattached, unengorged chigger was made at the type locality of *E. rubra* (pl. 2).

REMARKS: The original description of *E. setosa* included the species in an "akamushi" group of the genus *Trombicula*. *E. setosa* was included in a key of the "akamushi" group. The type slide given was USNM 1256; the type host, *Peromyscus g. gossypinus*; the type locality, Okefenokee Swamp, Ga. Fuller (1948) examined the cotypes and placed the species in the genus *Euschöngastia*. The original description and key validated the name. The type specimen or the cotypes are the namebearers for the species. One of the cotypes of *E. setosa* has been examined during this study. The important sensillae are missing, but the specimen belongs to *Euschöngastia*. Fuller's new combination is here considered to be correct and the name of the species to be *E. setosa*.

The specimen on the slide in the U. S. National Museum marked "C. E. F. X." is here designated lectotype.

24. *Euschöngastia sciuricola* (Ewing)

FIGURE 8,a; PLATES 8, 21

Schöngastia sciuricola Ewing, 1925b, pp. 261-262; 1929c, p. 297.

Neoschöngastia sciuricola, Ewing, 1931, p. 5.—Radford, 1942, p. 74.—Sig Thor and Willmann, 1947, pp. 311, 312.

Euschöngastia americana Ewing, 1938, p. 293; 1946c, p. 22.—Sig Thor and Willmann, 1947, p. 317.—Fuller, 1952, pp. 182, 183.

Euschöngastia sciuricola, Fuller, 1948, p. 108; 1952, pp. 182, 183, 184.—Brennan, 1948, p. 473.—Wharton, Jenkins, et al., 1951, pp. 27-28.

DESCRIPTION: Size: Length, 430 to 740; width, 310 to 675.

Shape: Oval; ovoid; almost round.

Gnathosoma: Seta on palpal femur rather long with long, spaced setules. Seta on palpal genu smaller with two rows of slender setules. Dorsal seta on palpal tibia with few setules; lateral seta nude, occasionally with one or two tiny setules; ventral seta rather long with three or four rows of setules. Palpal claw curved, with five to seven prongs; median prong longest with two accessories slightly shorter; other prongs more proximal on the convex curvature. Galeal seta with about two to four setules. Chelicera with heavy basal segment; blade with a tiny, distinct dorsal tooth near apex and a larger ventral tooth. Punctae on palpal coxa; none apparent on cheliceral base.

Legs: Leg I with two slender genualae and a microgenuala, two tibialae and a microtibiala, a spur with a microspur about two-thirds the length of the spur distal and slightly posterior to it, a subterminala, a parasubterminala, and a pretarsala. Leg II

with a slender genuala, two rather small tibialae, a tapered spur with a microspur just proximal to it, and a pretarsala. Leg III with a genuala. Nonspecialized leg setae similar in form and arrangement to those of *E. setosa* but somewhat longer. Empodium slender, longer than the claws. Fine punctae sometimes discernible on coxae; other leg segments apparently without punctae.

Scutum: Somewhat similar in general form and outline to that of *E. blarina* but larger and more extended at the posterolateral corners. Apparently subject to distortion. Crescentic ridge anterior to each pseudostigma; usually obscured. No punctae apparent. Pits usually present about midway between the posterolateral seta and the pseudostigma on each side. Setae similar to those of *E. setosa*. Sensillae widely clavate; heads truncate at tips, closely covered with setules on the anterior surface, rather sparsely covered on the posterior surface; pedicels distinct.

Anomaly: Perhaps induced by flattening an engorged specimen on a slide, in one specimen the anterior and posterior margins formed concentric curves, and a line drawn between the posterolateral setae fell anterior to the anteromedian seta.

Standard data of a cotype of *E. americana* from Boise County, Idaho:

AW	PW	AP	SB	ASB	PSB	AL	AM	PL	S
68	95	22	25	21	12	34	34	66	22 x 17

Summary of standard data of five specimens, including the cotype (AL's, AM's, and S's from four specimens):

AW 62-80, mean 70.4; PW 82-119, mean 99.4; AP 18-22, mean 20.4; SB 25-44, mean 33.6; ASB 21-32, mean 25.4; PSB 8-18, mean 12.4; AL 34-38, mean 35.3; AM 34-39, mean 36.3; PL 66-79, mean 72; S 22-35, mean 29.5. Width of head of sensilla in four specimens, 15 to 17, mean 16.

Eyes: Two pairs; anterior pair lying just anterior to the posterolateral setae. Diameters of anterior eyes of three specimens, 9 to 12, mean 10.3; of posterior eyes, 9 to 10, mean 9.7.

Dorsal setae: Similar in form to those of *E. setosa*. Measurements from four specimens: Length of humerals, 58 to 70; of setae near the middle of the first posthumeral row, 44 to 54; of posterior setae, 35 to 36.

Dorsal formulae for five specimens:

Idaho

Boise County: 2 .. 12 .. 12 11 .. 7 .. 2

Montana

Ravalli County: 2 .. 10 .. 11 .. 2 .. 12 .. 8 .. 6 .. 2
 2 .. 11 .. 11 .. 1 .. 10 .. 7 .. 4
 2 .. 9 .. 11 .. 2 .. 10 .. 6 .. 6

British Columbia

Kamloops:

2 .. 10 .. 13 12 .. 5 .. 4

Ventral setae: Similar to those of *E. setosa*. Data from four specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 36 to 41. Length of first sternals, 44 to 55; of second sternals, 38 to 43; of setae near the middle of the first poststernal row, 29 to 36; of setae in the posterior group, 36 to 41.

MATERIAL: Cotypes of *E. sciuricola* (USNM 892) of *E. americana* (USNM 1277) and specimen from Kamloops, British Columbia, are in U. S. National Museum. Other specimens from Rocky Mountain Laboratory. Specimens from hosts:

<i>Sciurus</i> [= <i>Tamiasciurus</i>] <i>hudsonicus</i>	<i>Sciurus</i> [= <i>Tamiasciurus</i>] <i>h. streatori</i>
<i>richardsoni</i>	British Columbia
Montana	Kamloops: July 5, 1936, 1.
Florence: 19 (cotypes <i>E. sciuricola</i>).	Pine squirrel
Chipmunk	Montana
Idaho	Ravalli County: Dec. 1944, 1.
Boise County: Sept. 20, 1930, 1	<i>Tamiasciurus</i> sp.
(cotype <i>E. americana</i>).	Montana
	Ravalli County: Aug. 17, 1945, 1;
	Nov. 1945, 1.

SEASONAL DISTRIBUTION: *E. sciuricola* has been collected in July, August, September, and December.

GEOGRAPHIC DISTRIBUTION: *E. sciuricola* has been collected in Idaho, Montana, and British Columbia (fig. 8,a).

DIAGNOSIS: *E. sciuricola* can be distinguished from the other members of the "*blarinae*" group by the following combination of characters: Posterior body setae not leaflike, scutum and free leg segments without punctae, head of sensilla cordiform. It is much like the eastern *E. setosa*, from which it can be distinguished by the cordiform head of its sensilla, by the lack of punctae on its cheliceral base, and by the more distinct dorsal tooth on its cheliceral blade.

REMARKS: The specimens in the U. S. National Museum comprising the cotypes of *E. sciuricola* are badly distorted. The specimens comprising the cotypes of *E. americana* are reasonably distinct. So far as can be determined at this time, there is no essential difference between the two. From the original descriptions the palpal claw might be used as a distinguishing character. The palpal claw of *E. sciuricola* was given as 3-pronged; that of *E. americana* as 5- or 7-pronged. The palpal claw of *E. americana* conforms with the original description. The palpal claw cannot be seen clearly on the cotypes of *E. sciuricola*, but there are indications of five prongs. The type specimens of *E. sciuricola*

were collected from the squirrel, *Tamiasciurus hudsonicus richardsoni*, at Florence, Ravalli County, Mont. Chiggers of this type have been collected subsequently from *Tamiasciurus* sp. in Ravalli County. All have had five or more prongs on the palpal claw. The evidence now available indicates that *E. sciuricola* and *E. americana* are the same species. In Wharton, Jenkins, et al. (1951), the two species are listed as being synonymous. *E. americana* is here considered to be a synonym of *E. sciuricola*.

The single specimen on the slide in the series of cotypes marked "C. E. F. X." is here designated lectotype.

25. *Euschöngastia* sp.

FIGURE 8,a; PLATES 8, 20

DESCRIPTION: Size: Length, 270 to 700; width, 225 to 505.

Shape: Ovoid to broad ovoid; broad oval.

Gnathosoma: Setae generally like those of *E. sciuricola*. Lateral seta on palpal tibia nude. Number of prongs on the palpal claw variable in the five specimens and on the two claws of three specimens; the distribution of prongs on the palpal claws of the five specimens are as follows: Three and three prongs, three and four prongs, three and five prongs, four and four prongs, and four and five prongs. Dorsal tooth on the cheliceral blade farther from the tip of the blade than in *E. sciuricola*. Punctae as in *E. sciuricola*.

Legs: Characters generally as for *E. sciuricola*.

Scutum: Characters generally as for *E. sciuricola*. Posterior margin tends to be more convex; lateral margins tend to be less concave. Setae tend to be heavier. Sensillae rounded at tips.

Summary of standard data of five specimens from Ravalli County, Mont. (AM's and S's for four specimens):

AW 62-72, mean 67.8; PW 91-99, mean 96; AP 17-24, mean 20.8;
SB 23-29, mean 26.6; ASB 25-31, mean 27.4; PSB 8-15, mean 12.4;
AL 43-50, mean 47.2; AM 32-41, mean 37; PL 70-76, mean 71.2;
S 25-28, mean 25.8. Width of head of sensilla in four specimens,
all 17.

Eyes: Two pairs; anterior pair lateral to the posterolateral setae. Diameters of anterior eyes of three specimens, 12 to 13, mean 12.7; of posterior eyes, 11 to 14, mean 12.3.

Dorsal setae: Generally similar in form to those of *E. setosa*. Somewhat heavier than those of *E. sciuricola* and more numerous. Length of humerals of five specimens, 67 to 72; of setae near the middle of the first posthumeral row, 50 to 57; of setae in the posterior group, 42 to 48.

Dorsal setal formulae for five specimens from Ravalli County, Mont.:

2	..	13	..	12	..	2	..	16	..	8	..	6
2	..	14	..	16	..	..	14	..	8	..	8	.. 4
2	..	14	..	12	..	..	12	..	10	..	6	
2	..	12	..	13	..	2	..	12	..	7	..	6 .. 3
1	..	11	..	12	..	..	12	..	9	..	6	

Note: It could not be determined if the final specimen of the series was anomalous by lacking a humeral seta or if the seta had been lost.

Ventral setae: Similar to those of *E. setosa*. Data from five specimens: Number of first sternals, 2; of second sternals, 2; of poststernals, 43 to 50. Length of first sternals, 48 to 57; of second sternals, 38 to 50; of setae near the middle of the first poststernal row, 31 to 36; of setae in the posterior group, 40 to 48.

MATERIAL: All specimens from the Rocky Mountain Laboratory. Specimens from hosts, all from Montana:

Marmota flaviventris

Ravalli County: Apr. 18, 1943, 1.

Marmota f. nosophora

Ravalli County: May 2, 1945, 2;
May 10, 1945, 2.

SEASONAL DISTRIBUTION: *Euschöngastia* sp. has been collected in the spring months of April and May.

GEOGRAPHIC DISTRIBUTION: The only known collections of *Euschöngastia* sp. have been made in Ravalli County, Mont. (fig. 8,a).

DIAGNOSIS: Because of uncertainty concerning the position of *Euschöngastia* sp., no diagnosis is given.

REMARKS: The five specimens described here appear to be morphologically distinct. Apparently the form they represent has a host preference for marmots, which further differentiates them. At the same time they exhibit great similarity to *E. sciuricola*, found on squirrels in the same geographic range. Collections of the two forms have been made at different seasons. The history of the five specimens has not been determined. It is not known whether they constitute the total collections of the form from marmots or if they are a sample from larger collections.

Characters by which the five specimens differ from *E. sciuricola* include the number of dorsal setae and the number of prongs on the palpal claw. However, the data for both characters of the two forms can be put together to make continuous series. The highest dorsal setal count of *E. sciuricola* slightly overlaps the lowest count for *Euschöngastia* sp. But when the data for the total number of dorsal setae are put together in this way, the

variation is considerably greater than that usually found in species of *Euschöngastia*. The unusual extent of the variation is easily apparent in the first posthumeral row of setae for the two forms. The lowest count of the number of prongs on the palpal claw of *E. sciuricola* coincides with the highest count determined for *Euschöngastia* sp. When the data for the number of prongs on the palpal claw of the two forms are put together, the range of variation becomes extreme, but it is continuous.

The variation in the number of prongs on the palpal claw of *E. sciuricola* is not remarkable. However, the variation exhibited by the five specimens of *Euschöngastia* sp. has no precedent. The number of prongs on the palpal claw of all other North American *Euschöngastia* is very constant and has been useful in arranging the chiggers into apparent natural groups. The striking variation of the number of prongs on the palpal claw of *Euschöngastia* sp. cannot be explained until a longer series of specimens has been examined.

The sample available at this time is not adequate for making a determination of the position of *Euschöngastia* sp.

Discussion

A systematist engaged in separating and defining species must have some clear concept of these populations. Any definition which he may develop will be shaped by what he finds in his material and should be more clear the more intimately he knows the material. The many diverse definitions of species with which students are familiar all tend to reflect the varying interests of the authors. It follows that, whatever its scope, the definition of a working systematist must be useful. On these grounds, a species of *Euschöngastia* in this paper is a population of chiggers which conforms to a morphological pattern, normally variable within limits, which is found in a certain ecological pattern within a geographic range, and which is biologically continuous. The morphological pattern of the species can be observed and charted. The ecological pattern, including the distribution of the chiggers before attachment, the host distribution and the localization on hosts during attachment, and the seasonal distribution is determinable. The geographic range can be plotted. Chiggers are not the reproductive stage of the trombiculid life cycle, but their biological continuity is evident in collections of succeeding years. According to this concept, a species of *Euschöngastia* is natural and definable.

Much of the basic work on systematics is concerned with mor-

phology. According to Simpson (1945), "It is not useful to set up a classification in which groups with different names cannot be distinguished morphologically." All species of *Euschöngastia* included in this paper have been defined morphologically. This includes an enumeration of the various features which characterize each species, but it does not imply a static definition. Given a series of specimens sufficiently long, it is doubtful if there is any morphological character which cannot be found to vary. Variability is an expression of the genetics of the species, and is itself a character of the species. An adequate morphological definition should include these variations. However, it is standard practice to identify specimens initially by means of diagnostic or systematic characters, those characters which differ between known species. Use of these practical tools of the systematist saves both time and effort. But these characters are only systematic aids, and a species of *Euschöngastia* is not a "nude lateral seta on the palpal tibia" or a "mastitarsala III." Following a tentative identification on the basis of diagnostic or key characters, the specimen should be compared with the complete description, with other identified specimens, and, when possible, with type material. This final comparison is important in *Euschöngastia*. Undoubtedly, many species remain undescribed.

Study of North American *Euschöngastia* reveals that at present it contains four well-defined groups of species, three somewhat less well-defined groups of species, and four ungrouped species—a total of 24 species (excluding *Euschöngastia* sp.), with one of these divided into two subspecies. These species have certain relationships with each other which can be used to segregate either groups of species or the species themselves.

When attention is given to particular systematic characters, it is found that fundamental cleavages can be made in the genus by use of the specialized, or striated setae of the legs. The value of these setae in descriptions and diagnoses was pointed out by Wharton (1947a). In particular he emphasized the striated setae of the third leg as being important in separating morphological groups of species in the genus *Trombicula*. In *Euschöngastia* these setae have a similar importance. On the clear basis of the presence or absence of the tibiala on the third leg, the genus in North America can be split through the middle, so that each half contains groups of morphologically related species. Also, the presence or absence of other striated leg setae distinguishes definite groups. Thus, the absence of subterminalae and parasubterminalae separates the "*lacerta*" group from all others. The

number of genualae in the first leg separates *E. trigenuala* from the "*pipistrelli-oregonensis-samboni*" group. The striated leg setae have some usefulness at the level of the species. *E. luteodema* is quickly separated from *E. marmotae* by the absence of genualae II and III. The mastitarsala on the third leg of *E. nuñezi* is unique in North American *Euschöngastia*. It might easily be one of the characters of a distinct group.

Another character of basic importance is the number of prongs on the palpal claw. The diagnostic value of this character was first recognized by Ewing (1938). He used it to separate the two genera *Neoschöngastia* and *Euschöngastia*. *Neoschöngastia* was diagnosed as having two or three prongs on the palpal claw; *Euschöngastia* was diagnosed as having more than three prongs. Ewing (1946b) separated *Ascoshöngastia* from *Neoschöngastia*. *Ascoshöngastia* was diagnosed in part as having two or three prongs on the palpal claw. Wharton (1948) rejected Ewing's diagnosis of *Ascoshöngastia* and gave a new diagnosis to *Euschöngastia*. By the new diagnosis certain species with two or three prongs on the palpal claw, formerly placed in *Ascoshöngastia*, were included in *Euschöngastia*, which, as stated above, had been diagnosed originally as having more than three prongs. Since the diagnosis of *Euschöngastia* accepted for this paper is basically Wharton's, it is obvious that the number of prongs on the palpal claw is a systematic character useful in separating groups of species.

Following the fundamental divisions based on the two characters discussed above, a variety of characters are useful. The nonspecialized setae of the gnathosoma, the various leg setae, and the body setae are important. The scutum and the sensillae often are distinctive. Various ornamentations occur consistently in different species. The number of eyes and the development of the eyes are useful in a few instances. Color is helpful, but it cannot be determined from a mounted specimen. Size and shape are subject to change in preservation on slides and can be used in few species. However, color, size, and shape are potentially useful in identification of living material, particularly unengorged specimens.

Differences have been found in the number of setules on the setae of the gnathosoma among the species included in this paper. These setae are recognized by all workers in the genus who include at least some of them in descriptions and diagnoses. In the present study the galeal seta and the lateral seta on the palpal tibia were selected for special consideration. Whenever the num-

ber of setules on either of these setae was charted for a species, the distribution always appeared normal (tables 6, 12-15). The taxonomic importance of these selected setae is shown most clearly in the "*rubra*" group (fig. 6,a,b). In this group each of the four related forms has a characteristic distribution of setules. Determinations of distributions of these sorts must be made on a group basis, but, having been made, the data may be used for the identification of single specimens. Differences can be found in the number of setae on the palpal tarsus, but these are associated with chiggers which are distinct on other grounds.

The feathered setae of the legs have not been considered as systematic characters by most workers. Floch and Abonnenc (1941) enumerated these setae by leg segments for *E. guyanensis*. Wharton (1946) enumerated them by leg segments for *Euschöngastia indica*. His count coincides well with the number of setae found in the "*lacerta*" group and on *E. nuñezi*. These species have eight feathered setae on the tibia of the first leg. All other North American species have seven feathered setae on this segment. Possibly the number of feathered setae on the first tibia will prove diagnostic at the level of groups of species. In *E. guntheri* the two setae on the coxa of the third leg are diagnostic at the level of species. Differences occur in the number of feathered setae on the tarsi of certain species; but accurate determination of this is laborious and is not required at the present time. With the exceptions mentioned, the number of feathered setae on the leg segments of *Euschöngastia* studied are the same.

Acarologists have not used the structure of the feathered setae of the legs of chiggers as a systematic character. Gunther (1940) made brief descriptive statements concerning them in describing new species. Later workers have used only a descriptive term, if the setae were mentioned at all. In the present study the structure of these setae was found to differ considerably between many species while remaining constant within a species. This is in contrast to the general uniformity within the genus of the number of the setae per segment. The structure of these feathered setae is useful as a key character in separating the "*luteodema*" group from the "*criceticola-californica*" group. The very similar *E. criceticola* and *E. californica* themselves can be separated by this character, and it could be used elsewhere.

The arrangement of the dorsal setae into rows is conspicuous and lends itself well to counting. Consequently these setae have been used by most acarologists. Ewing (1937), in discussing the setae, stated that their number probably did not vary within a

species. This statement does not hold in *Euschöngastia*. A series of dorsal formulae for any species shows a range of variation in the number of setae. However, Ewing's observation that the positions of the setae change with engorgement is true within this genus. Varying degrees of engorgement doubtless account for certain variations in the dorsal formulae determined for a species. The effect is most noticeable on the posterior portion of the body which undergoes greatest change during engorgement. The anterior rows are quite distinct in all engorgements. Also, this factor may in part be responsible for the lateral setae. These setae apparently are lateral extensions of the dorsal rows. Their appearance out of line may be the combined result of displacement by engorgement and a flattening of the specimen on the slide. During a large portion of this study, an effort was made to assign the laterals to the rows of dorsals. It can be questioned whether this is the better procedure, since including the setae in the formulae as laterals conforms more closely with the distribution observed on a specimen. Usually the dorsal setae are clearly arranged in rows; and the length of each row conforms somewhat to the diameter of the body where it is found. In some species there are extra setae which may occur out of line. This condition is found in the "*luteodema*" group. It is most strongly developed in *E. guntheri*. In *E. magna* the extra setae occur as short rows between the longer rows. Each species of *Euschöngastia* has a characteristic pattern to its dorsal formula which is a valuable systematic aid.

Differences in structure of the dorsal setae have been recognized by several systematists. Earliest instances occurred when the setae assumed a leaflike shape. On this basis Gunther (1940) and Womersley (1944) used the shape of dorsal setae to distinguish new species. However, Lawrence (1949) determined differences in the more normally shaped body setae of African *Euschöngastia*. He figured both dorsal and ventral body setae for his new species and used the relative thicknesses of dorsal setae as key characters. In the present study these setae have been found to have similar systematic value for North American *Euschöngastia*. The flat, leaflike shape and the distribution of the posterior body setae are diagnostic in *E. carolinensis* and *E. ohioensis*. Within the "*rubra*" group the character is important. Here the setae have normally round shafts, and the difference involves the setules of the posterior setae. The relative size of the setules on the dorsal setae is useful in distinguishing between *E. setosa* and *E. blarinae*. Potentially the structure of the dorsal

body setae is useful in other species. Observation indicates that the structure of the dorsal setae is more constant than their numbers.

The ventral setae, except the sternals, are not easily assignable to rows. Usually they are rather numerous in *Euschöngastia*, and counting them becomes laborious. Some descriptions (Womersley, 1944) list the setae by rows when the number is small. When the number is large, the approximate total number may be given (Wharton, 1948, and Brennan, 1947, 1948). The latter method is used in this paper. Usually the poststernal setae increase in size posteriorly. Brennan (1948) has referred to a difference in form between the setae anterior to the anus and those posterior to the anus, with the posterior setae frequently resembling the dorsal setae. This difference has been found in certain species in the present study, being most clearly shown in *E. nuñezi*. In other species, such as *E. peromysci* and *E. rubra*, the dorsals and all poststernal ventrals have the same form.

The scutum, with its associated setae and sensillae, is a very remarkable structure. It has been much used by all workers in defining and diagnosing species. In *E. nuñezi*, *E. trigenuala*, *E. peromysci*, *E. rubra*, *E. hamiltoni*, and possibly others the outline and markings of the scutum are so distinctive that they alone may serve to diagnose the species. In all species they are characteristic and helpful. The markings usually consist of punctae and ridges. Caution must be exercised in using these structures, since ridges frequently are obscured on wide scuta, such as occur in the "*blarinae*" group, and punctae may be obscured in any species. The sensillae also are distinctive in many species. *E. nuñezi*, *E. criceticola*, and *E. blarinae* are examples. Sensillae are always useful but, regrettably, are often lost. Both length and structure of the scutal setae are useful systematic characters in certain species, such as *E. pipistrelli* and *E. hamiltoni*.

Womersley and Heaslip (1943) introduced the series of measurements known as the standard data of the scutum. These data are an expression of size and proportion of the scutum and as such are useful in systematics. Womersley and Kohls (1947) treated the standard data statistically in describing new species of *Euschöngastia* from New Guinea. In the present study no effort was made to use statistical methods with the data.

From observation of numerous specimens, it seems that the scutum is subject to change or deformation in many species. Particularly in species with wide scuta, larger scuta are associated with well engorged specimens. This is in accord with

Wharton and Hardcastle (1946), who found the scuta of larger specimens of their new species *Neoschöngastia ewingi* were larger than the scuta of unengorged specimens. The scuta also differed in shape. The drawing of the scutum of *E. setosa* (pl. 8,c) was made from a well engorged specimen which was flattened on the slide. It measures 112 microns between the posterolateral setae. This is the largest measurement recorded for a scutum of *E. setosa*. A scutum obviously deformed as a result of preservation on a slide was found in *E. sciuricola*. Wharton and Hardcastle point out that it is clear that changes can occur in the character of the scutum of an individual chigger, and mistakes may result from placing too much emphasis on the standard data. This statement is supported by present observations on the scuta of *Euschöngastia*. Judged in this light, the clinal nature exhibited by the size of the scutum of *E. peromysci* (fig. 5,a) and that of *E. diversa diversa* (fig. 5,c) are not above suspicion. However, the figures referred to (charting this feature for the two species) are included on the basis of the presumed random selection of the specimens represented.

The presence or absence of punctae on the cheliceral base, the palpal coxa and femur, the leg segments, and the scutum may be of systematic value. Lawrence (1949) used the difference in size of scutal punctae as a key character. Differences in size of punctae occur in North American *Euschöngastia* and have been used as diagnostic aids. Usually, however, advantage is taken of the differences in distribution of the punctae. Within certain species the punctae characteristically are present on some parts and absent on others. This aid has been of particular value among certain species of the "*blarinae*" group.

The eyes are of distinct, though limited, systematic value. Most species have two pairs of eyes not held in ocular plates. In *E. pipistrelli*, with its one small and indistinct pair of eyes, the character is important. In *E. trigenuala* the eyes are reduced apparently to one pair, but this species is quite distinct on other criteria. *E. lacerta* and *E. nuñezi* are the only species studied in this work which have ocular plates. Occasionally, in an unengorged specimen of one of the other species, the eyes may be close together and appear to be in an ocular plate.

Differences occur in the size of the teeth on the chelicerae. For example, these are rather large in *E. crateris* and quite small in *E. blarinae*. Usually the dorsal tooth cannot be detected in *E. blarinae*. Differences in the shapes of leg segments occur between

the species. Also, relative lengths of empodium and claws are often characteristic. These characters are included in the descriptions. At the present time it is not necessary to use them in diagnoses.

The method used in this paper to illustrate the descriptions of species of chiggers logically follows the method of study. Wharton (1947a) reported a shorthand system of taking notes on chiggers by making a series of drawings of morphological details. His method was used during the present study and was adapted for the illustrations in this paper. It represents a departure from the usual methods of authors. For example, Gunther (1940) drew the scutum, the cheliceral blade, and longitudinal halves of the dorsum and venter. Womersley (1944) also drew the scutum, but he included a ventral view of the gnathosoma, a dorsal view of the tarsus of the first leg, and full views of the dorsum and venter. Brennan (1948) included drawings of the scutum and longitudinal halves of the dorsum and the venter; in addition he illustrated a longitudinal, dorsal half of the gnathosoma. In the present paper the drawing of the scutum has been included; but almost all the other drawings of earlier authors have been omitted. There is little variation in the general organization of the body in species of *Euschöngastia*. The arrangement of the parts of the body is shown in figures 1 and 2. Such drawings have not been repeated for the species. Drawings of the dorsum and venter frequently do little more than show the number of setae and have been omitted. However, reflecting the emphasis in this paper placed on structures of the gnathosoma and the legs, a whole series of drawings illustrating details of these parts has been included. The drawings present the chigger in a highly dissected manner, but they are the direct result of giving attention to the whole mite rather than to a few restricted features. When the gnathosoma and the legs were included in the study, the higher magnifications of oil immersion lenses became necessary to study these features in detail. With such a method of study, the field of view is reduced and attention is given successively to separate small units. The present system of illustrating the descriptions was adopted as a practical method of presenting the characters on a scale sufficiently large to be useful.

Recently, photomicrography has been used as an aid to the study of the systematics of chiggers. Gill and Parrish (1945) gave directions for photographing the scuta of chiggers by using oblique light from the condenser to outline the structures more sharply. The method was employed by Brennan (1948) to obtain

photographs with which he very effectively supplemented his descriptions and his drawings. These photographs make possible a visualization which cannot be achieved through written descriptions or drawings. Also, by use of such photographs, the acarologist can approach, as closely as is possible, his desire to observe and compare specimens side by side, after the manner of the mammalogist. In the present work photography has been used as a systematic aid in a manner similar to that used by Brennan, although the phase microscope was substituted for the technique of oblique light.

Geography follows morphology in importance in the practical study of systematics. Wallace (1880) said, "Each species is moreover usually limited to one continuous area. . . ." Thus, the geographic range may be used as a check on the morphological species. There is no literature on the geographic distribution of North American *Euschöngastia* beyond the locality records accompanying the original descriptions of species. Collections remain meager. Through wide areas (fig. 8,b) records are completely lacking. The ranges, therefore, are incompletely known, but in every case where the range of a species has been charted a logical geographic area has been indicated (figs. 4, 7, 8). Whenever the range is at all extensive, such as that of *E. pipistrelli*, *E. peromysci*, or *E. setosa*, a few intermediate collections point toward continuity of range.

Further, chiggers of the genus *Euschöngastia* have been collected extensively in the West in a few counties of Montana and Idaho. In the East extensive collections have been made over much of Pennsylvania and a few counties of Ohio and North Carolina. The species collected in each region have been distinctive. Due regard must be given to the blank spaces on the map (fig. 8,b), but no eastern species has been reported from the West. No western species has been collected in the East. However, at this time the evidence by no means permits any real delimiting of ranges for any species. *E. pipistrelli*, *E. peromysci*, and *E. diversa diversa* have the greatest extent of range from east to west known at present. But the westward limits may reflect merely the lack of collectors. Purely as an aid to study, species which for the present may be regarded as eastern include *E. pipistrelli*, *E. peromysci*, *E. rubra*, *E. magna*, *E. diversa diversa*, *E. diversa acuta*, *E. marmotae*, *E. hamiltoni*, *E. blarinae*, *E. carolinensis*, *E. crateris*, *E. ohioensis*, and *E. setosa*. Species which may be regarded as western include *E. lacerta*, *E. bigenuala*, *E. oregonensis*, *E. samboni*, *E. cordiremus*, *E. guntheri*,

E. criceticola, *E. californica*, *E. luteodema*, and *E. sciuricola*. The Mexican *E. nuñezi* is omitted from the list. Also omitted is *E. trigenuala*, since its locality is not known with certainty.

The importance of geography in the "*rubra*" group with its subspecies has already been discussed in the remarks accompanying the group. Reference has been made to the combined characters of morphology and geographic range in separating the southern *E. carolinensis* from the northern *E. ohioensis*. Available information indicates that each species of *Euschöngastia* has a definite geographic range. The range when known becomes a part of the species definition and a very useful systematic character.

Another phenomenon which follows from a study of the geographic distribution of a species is that of geographic variation. This implies the variations which occur in the characters of a species over its geographic range. Such variations were found and noted for characters of *E. pipistrelli*, *E. peromysci*, and *E. diversa diversa*. When the length of the palpal claw (fig. 5,b), the number of setules on the galeal setae (table 6), and the size of the scutum (fig. 5,a) were charted for *E. peromysci*, the characters were found to vary in each locality and between different localities. The same result was had when the size of the scutum of *E. diversa diversa* (fig. 5,c) was charted geographically. Moreover, when the variations of all these characters were arranged in a continuous gradient, some correlation with geographic direction became evident. In all cases the pattern of variability was the same, generally continuing from west to east, or from south and west to north and east. Huxley (1940) discussed such geographically correlated character-gradients. He termed them "clines" and pointed to their value in summarizing variations and in studying subspecific groupings. In the present paper they have been used only for their value in summarizing geographic variations in the characters of the species.

Information is not adequate for an evaluation of seasonal distribution of the species of *Euschöngastia* with regard to their systematics. From the records available it appears that different distributional patterns may be represented. The charted record of *E. rubra* (fig. 6,d) shows that it occurs on hosts only during the winter and spring. The known record of all the "*rubra*" group falls in this pattern. The record of *E. peromysci* (fig. 6,c) shows that it has a peak incidence on hosts during winter and spring, but it also occurs in smaller numbers during summer and fall. *E. luteodema*, *E. marmotae*, and *Euschöngastia* sp., which

occur on marmots, have been collected only in spring and summer. *E. blarinae*, *E. carolinensis*, *E. crateris*, *E. ohioensis*, and *E. pipistrelli* appear to be active at all seasons. There is obvious diagnostic value in a seasonal distribution such as that of *E. rubra* in which the species is restricted to certain months of the year. However, further collections, particularly of the sort that are made around the year in relatively restricted localities, should be available before determinations of the systematic value of seasonal distributions are attempted.

The systematic significance of the ecology of North American *Euschöngastia* can be discussed only in an introductory manner. Ecological information for the eastern species is fragmentary. Nothing is known of the western species beyond the information on the slide labels. Almost nothing has been done with the free-living stages, including the chigger itself before attachment. However, it was on the basis of ecology that Ewing (1929d) separated the vertebrate-infesting trombiculids from the arthropod-infesting trombiculids. Indications of differences in ecology are contained in the results of collections at a standing dead oak stub (pl. 2) and in the region of an andropogon field (pl. 3) in Duke Forest. It is to be anticipated that acarologists will use the data of ecology to diagnose at the level of species as the information is acquired.

Although this paper is concerned only with the parasitic chiggers, it is important in any discussion of the ecology of these mites to remember that the other stages of the trombiculid life cycle are not parasitic. Disregarding the physical factors of the environment, the trombiculid life cycle demands food in the form of suitable arthropod eggs or tissues during the nymphal and adult stages. Hosts are necessary for the larvae, or chiggers, during the parasitic stage. Since the larvae obviously cannot move far from the locality in which the adults reproduce, it follows that this locality must lie within the range of suitable hosts.

The ecological niches of the free-living stages of *Euschöngastia* remain almost unexplored. The preliminary investigations in the Duke Forest area were generally inconclusive so far as characters of systematic importance are concerned. There is some evidence that free-living *E. peromysci* are associated with well-decayed stumps. There is negative evidence that the niches of the other species were not found. Wharton's (1946) discovery of the free-living stages of *E. indica* in the nests of its host suggests a possibility for North American species, but nests occupied by the common hosts were not found during the present study. Further,

no adequate information of taxonomic significance has been derived from the larger habitat situations. Most species appear to be associated with forests. *E. diversa* seems to be associated with meadows or thickets. *E. blarinae* appears to be independent of any particular cover type and occurs wherever shrews are found. From the host records it might be inferred that certain species, such as *E. marmotae* or *E. pipistrelli*, have a different ecology. However, available information concerning habitats is too general for use in diagnosing species.

When the hosts of the *Euschöngastia* included in this paper are considered, it is found that the chiggers usually parasitize small mammals. Only *E. nuñezi* has been found on birds (fowls). Only *E. lacerta* has been collected from a cold-blooded host. When host relationships are considered more closely for those species which have been collected a number of times, certain host patterns become apparent. Occasionally there seems to be some host preference. One large group of chiggers is found on two or more of the smaller rodents—*Peromyscus*, *Clethrionomys*, *Synaptomys*, and others. These chiggers include *E. peromysci*, *E. cordiremus*, *E. rubra*, *E. magna*, *E. criceticola*, *E. ohioensis*, *E. crateris*, *E. carolinensis*, and *E. setosa*. *Euschöngastia diversa* also is found on smaller rodents, but the list differs to include *Microtus*, *Zapus*, and *Napeozapus* as important hosts, perhaps reflecting a difference in habitat. Another group of species is found on the large rodent, *Marmota*. These chiggers include *E. luteodema*, *E. marmotae*, and *Euschöngastia* sp. *E. sciuricola* has been collected from chipmunks and squirrels. *E. pipistrelli* and *E. hamiltoni* have been found only on bats. *E. blarinae*, except for the type specimen, has been collected entirely from shrews. These differences in host distribution seem to have diagnostic importance, although records are insufficient for comprehensive statements. At the present time it seems that *E. blarinae* can be separated from the similar *E. setosa* on the basis of the host record; but, because of the peculiar status of the type specimen of *E. blarinae*, morphology should always be included in this diagnosis.

Certain problems involving host relationships have already been discussed. These include the case of the type specimen of *E. blarinae*, the host relationships of the similar *E. carolinensis* and *E. ohioensis*, and the correlation of morphology with host preference of *E. luteodema* and *E. marmotae*. The host difference between *E. sciuricola* and *Euschöngastia* sp. has been considered. It was, in fact, the host difference—the one, arboreal; the other,

fossorial—which sharpened the suspicion aroused by the morphological differences between these forms. As a result, *Euschön-gastia* sp. is being held for further study.

In addition to the host record of a chigger, it is important to systematics to know as much as possible of the nature of the host-parasite relationship. It has been indicated that the separate ecologies of the host and the chigger must somewhere coincide. The systematist is better able to evaluate the host record if he knows to what degree a chigger is host-specific and to what degree its ecology assists or prevents its meeting certain hosts. Wharton (1946) working with *E. indica* on Guam, found the free-living stages in the arboreal nests of *Rattus mindanensis*. These rats were the only hosts found to be parasitized by the chiggers. Largely on the basis of previous experience with *E. indica*, Wharton inclined to the opinion that proximity was the more important factor in this parasitism. However, he was unable experimentally to infest *Rattus exulans* and *Mus musculus*—two ground-dwelling rodents found in the area—as well as guinea pigs and chickens. He did infest *Rattus mindanensis*. From these results he felt that host distribution was conditioned also by peculiarities of host and parasite. Lawrence (1949) was unable to affirm host-specificity for African trombiculids on mammals. He stated that some appeared to be host-specific, but this could have been the result of too few collections. In the present investigations only *E. peromysci* was used experimentally. *E. peromysci* has a wide range of hosts. Its lack of host specificity was confirmed in the laboratory. It attached to the skin of a man. It engorged on white mice. Further, no species of *Euschön-gastia* which has been collected a number of times has been found specific for a single host species. From this it seems quite possible that apparent host preference is but the reflection of the ecology of the free-living stages which places the chiggers in close spatial relationship with particular hosts.

However, as Wharton (1946) found, certain peculiarities of chigger and host may influence distribution. *E. blarinae*, for which a fairly long host record is available, seems to have a host preference for shrews. In Duke Forest unattached *E. blarinae* was collected—although never in large numbers—in combination with *E. peromysci*, which commonly attaches to *Peromyscus leucopus*. The sites were obviously available to *P. leucopus*. Yet, no *E. blarinae* was collected from this mouse. Also, the ubiquitous and nonhost-specific *E. peromysci*, found abundantly on *Peromyscus leucopus* in Duke Forest, was not taken from shrews in

the same area. There are only three records of *E. peromysci* from shrews in other areas. It seems obvious that the spatial relationships involved here could not be very great, and the record shows that unattached chiggers of the two species do mingle. It is possible that some character of host or parasite is operative in these cases to inhibit the shrew-*peromysci* and the mouse-*blarinae* associations.

Records are incomplete with regard to areas infested on hosts, but there are indications that useful characters can be determined. The "*rubra*" group and *E. peromysci* have been recorded only from the external auditory canal or deep in the ears of their hosts. *E. rubra* and *E. peromysci* commonly infest these areas in the ears of *Peromyscus leucopus*. In contrast, *E. crateris* is found in small craters on the edges and the distal surfaces of the ears of *P. leucopus*. On the same host, *E. ohioensis* is found attached around the anal area, with some records having it distributed over the abdomen, back, and legs. In these cases different species of chiggers attach to different areas of a single host species. It would seem that some character of the chigger is involved in determining the region of attachment, which then becomes useful in systematics. Another case concerns *E. blarinae*, which during this study has been found attached only in craters over the posterior portion of the body of *Blarina*. However, collectors have reported it from the folds of the pinna of *Sorex*. Superficially, this might indicate that the areas of attachment involve some characteristic of the host rather than of the parasite. But collectors have recorded *Trombicula jamesoni* Brennan, 1948, from the ears of *Blarina*. This contrasts with the areas observed to be infested by *E. blarinae* on the same host and points to characteristics of the chiggers as determining areas of attachment. In one of the two records of *E. peromysci* from *Blarina*, the collector listed the area of attachment. The chiggers were recorded from the ears. However, *E. blarinae* also was represented in the collection. The study is thus further complicated by the occurrence of more than one species of chigger on a single host. This factor must be recognized whenever any host-parasite relationship is being considered as a systematic character and due precautions must be taken to avoid error. It is interesting that Lawrence (1949) reports that *E. crocidurae* in Africa is found in pits in the skin of its host shrew. Further observation and study are necessary in order to determine the systematic value of the areas of attachment.

It is apparent, even with the scanty information available, that

variations in relation to the environment do exist among species of *Euschöngastia*. But it is equally apparent that ecological definitions and diagnoses are neither easily nor quickly acquired.

No information of value in systematics was derived from the extensive efforts to culture species of *Euschöngastia*. That portion of the trombiculid life cycle from unattached chigger, through engorgement, the detached chigger, and the nympho-chrysalis to the nymph was confirmed in the genus.

Finally, following separation and definition of the species on the basis of the available material, it might be well to consider in summary fashion the biological relationships of the species in the genus. According to Simpson (1945), "The genus tends . . . to be defined as a group of species possessing certain characters in common." Thorpe (1940) discussed briefly the impracticability of defining genera on other grounds. In giving the limits of the genus, Thorpe said, "For practical reasons the genus . . . must in general be neither too large nor too small." The genus, then, tends to be subjective. However, it is subjective only with respect to the definition of its limits, because groups of similar species do have an objectivity in nature, although the total array of species in the genus may not make up a morphological continuum from one form to the next.

Further, if similarly of morphology is evidence of relationship, the genus in North America is not merely an assemblage of species. It does, however, have at least three biological divisions. One of these is represented by *E. nuñezi* alone. This species, with the mastitarsala on the third leg, the nude pointed seta on the palpal tarsus, the two-pronged palpal claw, and unique scutum and sensillae, stands apart from all other species included in this paper. A second division is the "*lacerta*" group. This group of small mites, lacking the subterminala and the parasubterminala on the first leg, with a reduced number of setae on the palpal tarsus, with fine setae and setules on all parts, and with the proximal placement of the seta on the coxa of the third leg, is distinct. The remainder of the species comprise a third, general, broad division with *E. trigenuala* not well fitted in. This division contrasts in its morphology with the characters itemized for the first two. With regard to geographic distribution of these divisions, it can only be said that nothing inconsistent is apparent at present. On the other hand, the distributions are too insufficiently known to be discussed.

The third division includes several morphological groups which have been outlined in this paper for practical purposes. Closer

relationship is not necessarily implied in these groupings. But, to quote Simpson again, "Similar animals living in adjacent areas are likely to be more closely related than animals, even equally similar animals, widely separated . . . in fact, animals clearly cannot have common ancestry without also having common geographic origin." On this basis the forms within the "*rubra*" group are obviously related. The species of the "*blarinae*" group, excepting possibly *E. sciuricola*, appear to be related, with *E. carolinensis* and *E. ohioensis* having closer affinities. However, not enough is known of the species and their distributions to attempt any further genetic groups.

Bibliography

ANDRÉ, M.

- 1930. Contribution a l' étude d'un acarien: le *Thrombicula autumnalis* Shaw. Mém. Soc. Zool. France, vol., 29, pp. 39-138.
- 1943. Une espèce nouvelle de *Leeuwenhoekia* (acarien) parasite de scorpions. Bull. Mus. Hist. Nat. Paris, vol. 15, pp. 294-298.

AUDY, J. R.

- 1947a. Scrub typhus as a study in ecology. Nature (London), vol. 159, pp. 295-296.
- 1947b. Epidemiology of scrub typhus in Assam and Burma (Abs). Trans. Roy. Soc. Trop. Med. Hyg., vol. 40, pp. 359-360.

BANKS, N.

- 1915. The Acarina or mites. A review of the group for the use of economic entomologists. Rep. U. S. Dep. Agr., No. 108, pp. 1-153.

BERLESE, A.

- 1905. Acari nuovi. Manipulus IV. (Acari di Giava.) Redia, vol. 2, pp. 154-176.

BLAKE, F. G.; MAXCY, K. F., ET AL.

- 1945. Studies on tsutsugamushi disease (scrub typhus, mite-borne typhus) in New Guinea and adjacent islands: epidemiology, clinical observations and etiology in the Dobadura area. Amer. Journ. Hyg., vol. 41, pp. 243-373.

BOSHELL, J. AND KERR, J. A.

- 1942. Veinticinco especies nuevas de trombiculídeos en Colombia. Rev. Acad. Colombiana Cien. Exact. Fis. Nat., vol. 5, pp. 110-127.

BRENNAN, J. M.

- 1947. New species of chiggers (Acarina, Trombiculidae) from bats of the Nearctic region. Journ. Parasit., vol. 33, pp. 245-252.
- 1948. New North American chiggers (Acarina, Trombiculidae). Journ. Parasit., vol. 34, pp. 465-478.
- 1949. Tracheation in chiggers with special reference to *Acomatacarus arizonensis* Ewing (Acarina, Trombiculidae). Journ. Parasit., vol. 35, pp. 467-471.

BUXTON, P. A.

- 1945. Natural history of scrub typhus. Nature (London), vol. 155, p. 643.